AD-A129 783 CLEVELAND HARBOR OHIO DESIGN FOR THE SAFE AND EFFICIENT 1/4
PASSAGE OF 1000-F..(U) ARMY ENGINEER WATERWAYS
EXPERIMENT STATION VICKSBURG MS HYDRA.. R R BOTTIN
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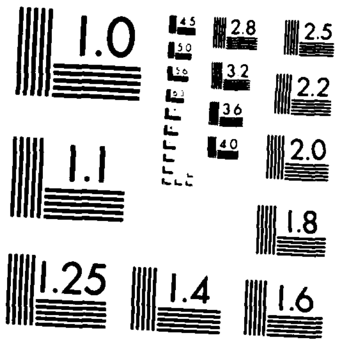


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TECHNICAL REPORT HL-83-6

# CLEVELAND HARBOR, OHIO
# DESIGN FOR THE SAFE AND EFFICIENT PASSAGE OF 1,000-FT-LONG VESSELS AT THE WEST (MAIN) ENTRANCE

## Hydraulic Model Investigation

by


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March 1983

Final Report

Approved For Public Release; Distribution Unlimited

Prepared for U. S. Army Engineer District, Buffalo
Buffalo, N. Y. 14207

Unclassified

SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

# REPORT DOCUMENTATION PAGE

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| | | |
|---|---|---|
| 1. REPORT NUMBER: Technical Report HL-83-6 | 2. GOVT ACCESSION NO.: AD A129 | 3. RECIPIENT'S CATALOG NUMBER: 283 |
| 4. TITLE (and Subtitle): CLEVELAND HARBOR, OHIO, DESIGN FOR THE SAFE AND EFFICIENT PASSAGE OF 1,000-FT-LONG VESSELS AT THE WEST (MAIN) ENTRANCE: Hydraulic Model Investigation | | 5. TYPE OF REPORT & PERIOD COVERED: Final Report |
| | | 6. PERFORMING ORG. REPORT NUMBER |
| 7. AUTHOR(s): Robert R. Bottin, Jr. | | 8. CONTRACT OR GRANT NUMBER(s) |
| 9. PERFORMING ORGANIZATION NAME AND ADDRESS: U. S. Army Engineer Waterways Experiment Station, Hydraulics Laboratory, P. O. Box 631, Vicksburg, Miss. 39180 | | 10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS |
| 11. CONTROLLING OFFICE NAME AND ADDRESS: U. S. Army Engineer District, Buffalo, 1776 Niagara Street, Buffalo, N. Y. 14207 | | 12. REPORT DATE: March 1983 |
| | | 13. NUMBER OF PAGES: 346 |
| 14. MONITORING AGENCY NAME & ADDRESS(if different from Controlling Office) | | 15. SECURITY CLASS. (of this report): Unclassified |
| | | 15a. DECLASSIFICATION/DOWNGRADING SCHEDULE |

16. DISTRIBUTION STATEMENT (of this Report)

Approved for public release; distribution unlimited.

17. DISTRIBUTION STATEMENT (of the abstract entered in Block 20, if different from Report)

18. SUPPLEMENTARY NOTES

Available from National Technical Information Service, 5285 Port Royal Road, Springfield, Va. 22151

19. KEY WORDS (Continue on reverse side if necessary and identify by block number)

Cleveland Harbor (Ohio)
Harbors--Ohio
Hydraulic models
Navigation
Water waves

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

A 1:100-scale (undistorted) hydraulic model of Cleveland Harbor, Ohio, which included the west (main) entrance to Cleveland Harbor opposite the mouth of the Cuyahoga River; approximately 8,800 ft of the harbor shoreline to the east of this entrance, including the western portion of Burke Lakefront Airport; the entire West Basin; Edgewater Marina; and sufficient offshore area in Lake Erie to permit generation of the required test waves, was used to investigate the effects of proposed improvements with respect to ship maneuverability, wave and current action, and riverflow conditions in the western portion of Cleveland Harbor. Proposed improvement plans at the Cleveland Harbor west entrance entailed (a) removal of portions of the existing breakwater spurs; (b) deepening and widening of the existing channel;

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(c) installation of additional breakwaters; and (d) modifications that involved raising and sealing and/or removal of portions of the existing arrowhead breakwaters. A 10-ft-long remote-controlled model ore carrier (representing a 1,000-ft-long vessel), a 120-ft-long wave generator, a model circulation system, wind generators, and an Automated Data Acquisition and Control System (ADACS) were utilized in model operation. It was concluded from test results that:

a. Existing conditions are characterized by rough and turbulent waves in the west entrance and at various locations in the Lakefront Harbor during periods of storm wave attack.

b. For existing conditions, the west entrance is not safe and efficient with respect to the navigation of 1,000-ft-long ore carriers even under fair-weather conditions (wave heights up to 4 ft and winds up to 20 knots (23 mph)).

c. For the safe and efficient passage of 1,000-ft-long vessels at the west entrance during fair-weather conditions, the east and west breakwater spurs should be reduced in length by a minimum of 200 ft and 300 ft, respectively (Fair-Weather Plan 1A).

d. The removal of the 200-ft and 300-ft lengths of the east and west breakwater spurs, respectively (Fair-Weather Plan 1A), will increase wave heights in the Lakefront Harbor.

e. Considering the safe and efficient passage of 1,000-ft-long vessels through the west entrance during fair-weather conditions and wave protection in the Lakefront Harbor (for all wave conditions), Fair-Weather Plan 4D (300-ft-long, parallel entensions to the outer ends of the arrowhead breakwaters, plus Fair-Weather Plan 1A) appeared to be optimum.

f. The optimum crest elevation of the west arrowhead breakwater of Fair-Weather Plan 4D (with respect to wave conditions in the Lakefront Harbor) was determined to be +14 ft (Fair-Weather Plan 5G). This elevation could be lowered to +10 ft probided the structure was sealed (Fair-Weather Plan 5C).

g. Of the improvement plans tested with the entrance oriented toward the west, Severe-Weather Plan 15 (entrance channel realigned to the west and protected by a 4,000-ft-long entension to the east breakwater and a 1,000-ft-long entension to the west breakwater) appeared promising considering wave protection in the Lakefront Harbor (for all wave conditions) and orientation of the navigation entrance. Subsequent testing, however, indicated navigational difficulties for severe-weather conditions (wave heights up to 8 ft and winds up to 30 knots (34.5 mph)).

h. Considering the safe and efficient passage of 1,000-ft-long vessels through the west entrance during severe-weather conditions and wave protection in the Lakefront Harbor (for all wave conditions), Severe-Weather Plan 16 (1,000-ft-long parallel entensions to the outer ends of the arrowhead breakwaters, plus Fair-Weather Plan 1A) appeared to be optimum.

## PREFACE

A request for a model investigation of Cleveland Harbor, Ohio, was initiated by the District Engineer, U. S. Army Engineer District, Buffalo (NCB), in a letter to the Division Engineer, U. S. Army Engineer Division, North Central (NCD). Funds for the U. S. Army Engineer Waterways Experiment Station (WES) to conduct the study were authorized on 10 April 1979, 17 December 1979, 3 September 1980, 17 December 1980, 2 April 1981, and 21 December 1981.

The model study was conducted during the period February 1980-December 1981 by personnel of the Wave Processes Branch (WPB), Wave Dynamics Division (WDD), Hydraulics Laboratory, WES, under the direction of Mr. H. B. Simmons, Chief of the Hydraulics Laboratory; Mr. F. A. Herrmann, Jr., Assistant Chief of the Hydraulics Laboratory; Dr. R. W. Whalin, former Chief of the WDD; and Mr. C. E. Chatham, Jr., Acting Chief of the WDD. The tests were conducted by Mr. H. F. Acuff, Civil Engineering Technician, with the assistance of Messrs. R. E. Ankeny, Computer Technician, and L. L. Friar, Electronics Technician, under the supervision of Mr. R. R. Bottin, Jr., Project Manager. This report was prepared by Mr. Bottin.

Prior to the model investigation, Messrs. Chatham and Bottin met with representatives of NCB and visited the Cleveland Harbor site. During the course of the investigation, liaison between NCB and WES was maintained by means of conferences, telephone communications, and monthly progress reports.

The following personnel visited WES to observe model operation and/or participate in conferences during the course of the model study.

| | |
|---|---|
| Mr. Larry Hiipakka | NCD |
| Mr. Charlie Johnson | NCD |
| Mr. Charles Larsen | NCD |
| Mr. Dave Roellig | NCD |
| Mr. Don Liddell | NCB |
| Mr. Ken Hallock | NCB |
| Mr. Denton Clark | NCB |
| Mr. Dick Aguglia | NCB |
| Mr. Jim Henry | NCB |
| Mr. Richard Gorecki | NCB |

| | |
|---|---|
| Mr. John Zorich | NCB |
| Mr. Charles Gilbert | NCB |
| Ms. Joan Pope | NCB |
| Mr. Stephen Golyski | NCB |
| CAPT W. J. McSweeney, Retired | Interlake Steamship Co. |
| ADM Paul Trimble, Retired | President, Lake Carriers Assoc. |
| Mr. Harry Gard | Cleveland/Cuyahoga County Port Authority |
| Mr. John Manning | Hanna Mining Company |
| Mr. M. P. Travis | Hanna Mining Company |
| CAPT G. V. Chamberlain, Retired | Hanna Mining Company |
| Mr. Robert Clark | Consolidated Rail Corp. |
| Mr. William Frederick | Consolidated Rail Corp. |
| Mr. Moe Rubinsky | Soro Associates |
| Mr. Joseph Hayes | Lake Erie Asphalt |
| CAPT Alton H. Haynes | American Steamship Co. |
| Mr. James Swartzmiller | Ohio Dept. of Natural Resources |
| Mr. Norv Hall | Ohio Dept. of Natural Resources |
| Mr. Bob Lucas | Ohio Dept. of Natural Resources |

CAPT William J. McSweeney, retired vessel master of the 1,000-ft-long M/V Mesabi Miner owned by the Interlake Steamship Company, was present at WES during the initial phases of model ship navigation tests. He returned to assist with the final model navigation tests. During his latter visit, he was joined by CAPT Alton H. Haynes, vessel master, employed with the American Steamship Company, and CAPT G. V. Chamberlain, retired vessel master formerly employed with Hanna Mining Company. CAPT Haynes and CAPT Chamberlain have also been vessel masters of some of the 1,000-ft-long ore carriers presently plying the Great Lakes.

Commanders and Directors of WES during the conduct of the investigation and the preparation and publication of this report were COL Nelson P. Conover, CE, and COL Tilford C. Creel, CE. Technical Director was Mr. F. R. Brown.

CONTENTS

CONVERSION FACTORS, U. S. CUSTOMARY TO METRIC (SI)
UNITS OF MEASUREMENT

U. S. customary units of measurement used in this report can be converted to metric (SI) units as follows:

| Multiply | By | To Obtain |
|---|---|---|
| acres | 4046.856 | square metres |
| cubic feet per second | 0.02831685 | cubic metres per second |
| feet | 0.3048 | metres |
| feet per second | 0.3048 | metres per second |
| inches | 25.4 | millimetres |
| knots | 1.8532 | kilometres per hour |
| miles (U. S. statute) | 1.609344 | kilometres |
| miles per hour | 1.609344 | kilometres per hour |
| square feet | 0.09290304 | square metres |
| square miles (U. S. statute) | 2.589988 | square kilometres |
| tons (2,000 lb, mass) | 907.1847 | kilograms |

CLEVELAND HARBOR, OHIO
DESIGN FOR SAFE AND EFFICIENT PASSAGE OF
1,000-FT-LONG VESSELS AT THE WEST
(MAIN) ENTRANCE

Hydraulic Model Investigation

# PART I: INTRODUCTION

## The Prototype

1. The city of Cleveland, Ohio, is located on the southern shore of Lake Erie, 96 miles* east of Toledo, Ohio, and 176 miles west of Buffalo, New York (Figure 1). With a population of 750,000 people, it is the largest city in Ohio and the tenth largest in the United States.

2. Cleveland Harbor is situated at the mouth of the Cuyahoga River. It is protected by a breakwater over 30,000 ft in length with

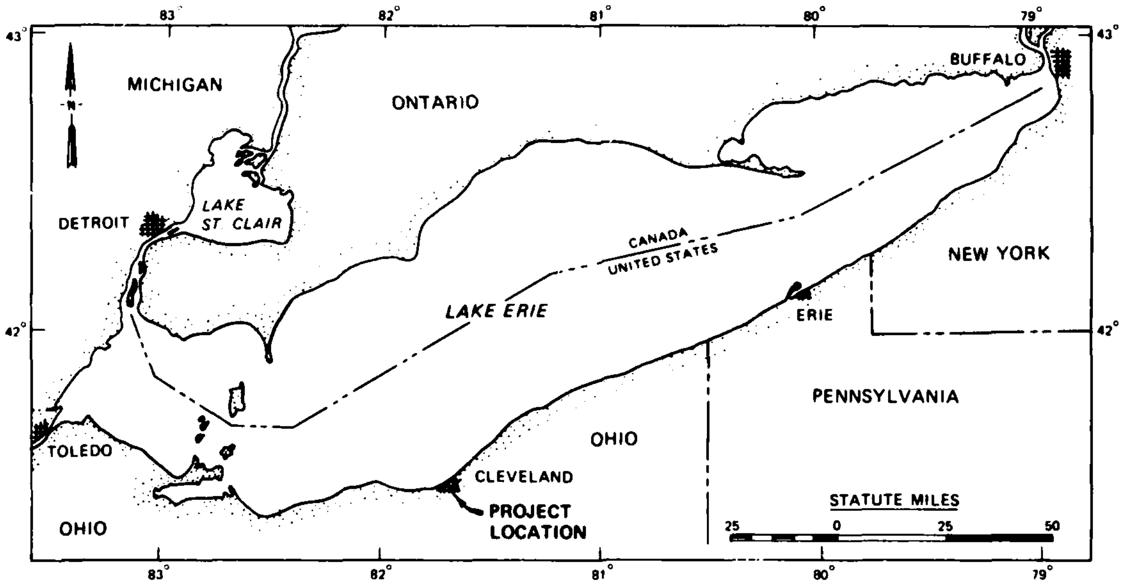


Figure 1. Project location

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* A table of factors for converting U. S. customary units of measurement to metric (SI) units is presented on page 4.

navigation channels on the Cuyahoga River and Old River. The harbor area comprises approximately 1,300 acres and extends for a distance of about 25,000 ft parallel to the shore (USAEDB 1976). Approaching from Lake Erie, there are two harbor entrances. The west entrance is located lakeward of the Cuyahoga River mouth and the east entrance is at the eastern end of the east breakwater. Also, small boats can enter the harbor through a narrow opening in the west breakwater at the entrance to Edgewater Marina. An aerial photograph of Cleveland Harbor is shown in Figure 2.

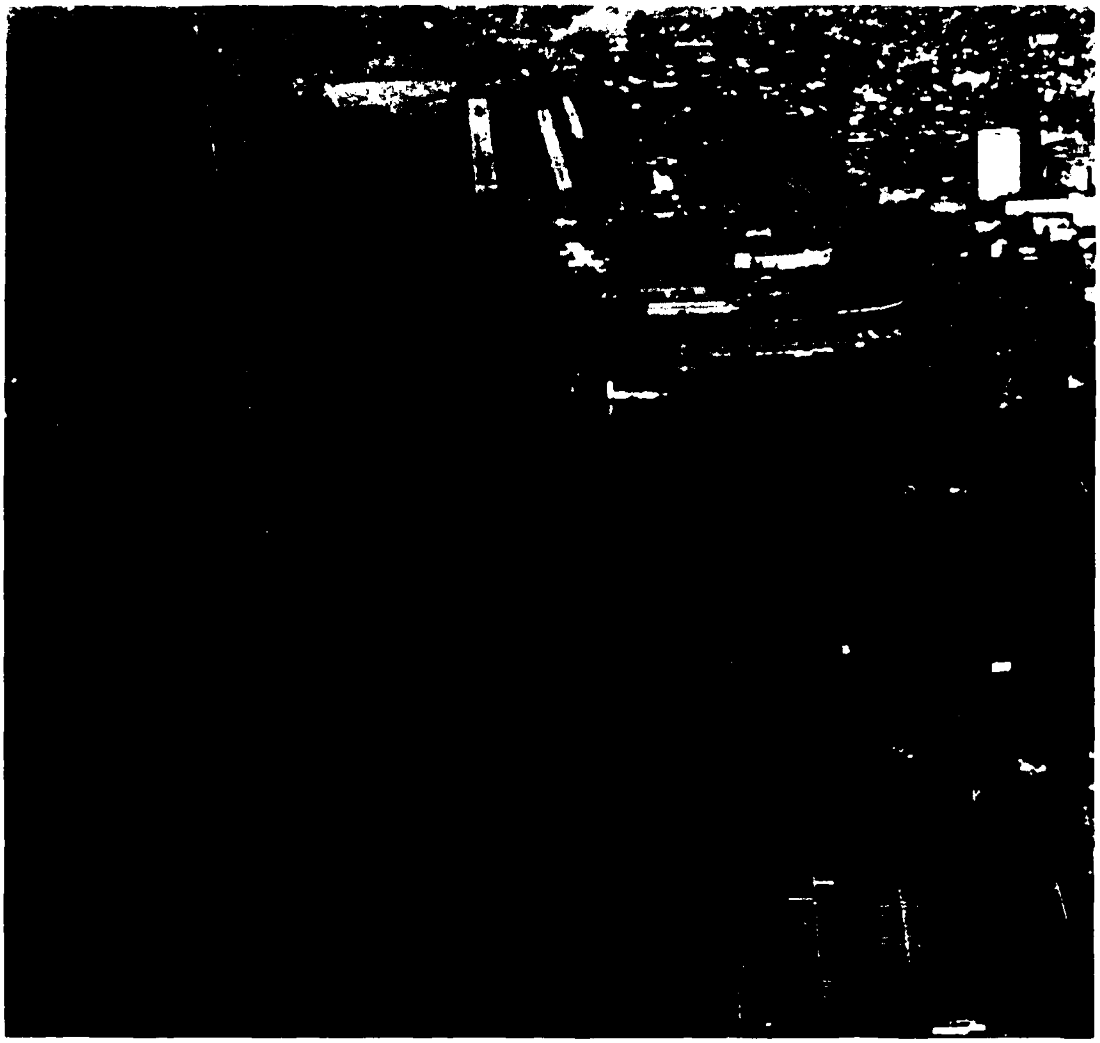

Figure 2. Aerial photograph of Cleveland Harbor

3. The east breakwater consists principally of dumped core stone that is covered with large individually placed armor stone. The west breakwater, a stone-filled timber crib structure with a concrete cap, is protected by a stone-sloped revetment on the lakeward side.

4. The main arrowhead entrance (west entrance) is maintained at a project depth of 29 ft (Figure 3, page 11). Depths in the West Basin and part of the East Basin are maintained at 28 ft. The remaining portion of the East Basin, opposite the cargo docks, is 27 ft deep and the channel through the East Basin to the east entrance is maintained at 25 ft.

5. The entrance to the Cuyahoga River is bounded by parallel stone-filled timber cribs with concrete superstructures located : ft apart. The river and its tributaries drain an area of about 810 are miles. The width of the river varies from 20 to 85 ft and its de from a few inches to 4 or 5 ft, except in Cleveland where the ri channel has been widened to about 300 ft and dredged to 23 ft.

6. Edgewater Marina is located adjacent to the western boundary of Cleveland Harbor. The marina basin is essentially rectangular in shape, measuring approximately 1,550 ft by 850 ft, and moors or docks over 600 recreational small boats. The Cleveland Harbor west breakwater provides wave protection from the east, and a rubble-mound breakwater with vertical sheet piling on the marina side provides harbor protection for waves from the north and west.

7. Cleveland Harbor accommodates the waterborne movements of bulk and general cargo to and from the city of Cleveland and points inland, and serves developments within Cleveland and throughout industrial and commercial portions of the State of Ohio and adjacent states. During the period 1969-1978, an annual average of nearly 20,400,000 net tons of cargo entered the harbor and about 600,000 net tons of cargo was shipped from the harbor, ranking it as one of the major harbors on the Great Lakes. Vessel movements of bulk iron ore, stone, sand and gravel, and salt represented over 90 percent of this waterborne commerce. Forecasts indicate that these commodity movements will increase in the future and will continue to be the dominant portion of waterborne commerce at Cleveland.

## The Problem

8. Cleveland Harbor is currently limited to vessels of 730 ft in length or less in the Lakefront area while the Cuyahoga River prohibits passage of vessels longer than 630 ft. Due to inadequate depths in the eastern portion of the Lakefront Harbor and the breakwater configuration at the west entrance, the harbor cannot safely accommodate the larger vessels, up to 1,000 ft in length, that presently ply the Great Lakes. These 1,000-ft-long vessels have the capabilities of moving bulk commodities in larger quantitites at less cost per ton. Improvements to the existing harbor at Cleveland would permit the delivery of bulk commodities in larger vessels which would potentially save millions of dollars annually in transportation costs and would reduce or eliminate present navigation hazards.

## Proposed Improvement Plans

9. Possible improvements at Cleveland Harbor for safe and efficient passage of 1,000-ft-long vessels, as recommended in the 1976 Cleveland Harbor Feasibility Report, consist of the following (USAEDB 1979):

- a. Construction of a 1,200-ft-long rubble-mound breakwater extension at the east end of the east breakwater.
- b. Deepening of a fan-shaped approach channel extending 2,900 ft into the East Basin to 32 ft.
- c. Deepening of the existing 500-ft-wide East Basin channel to 28 ft.
- d. Lakeward extension of the main entrance (west entrance) approach channel and deepening of the main approach and entrance channels to 32 ft.
- e. Incremental removal of 500 ft of the existing west breakwater spur and 400 ft of the existing east breakwater spur at the arrowhead entrance to facilitate turning movements. Initially, 200 ft would be removed from the west spur and 100 ft from the east spur. Further increments would be removed only if actual vessel operations indicate that a greater gap width is required.

10. Additional studies and coordination with shipping interests,

subsequent to completion of the 1976 report, indicated that the recommended plan was not totally satisfactory and that additional plans to modify the west (main) entrance should be assessed. In addition, due to the limited operating experience with 1,000-ft vessels on the Great Lakes, physical modeling of any proposed modifications would be required.

## Purpose of the Model Study

11. At the request of the U. S. Army Engineer District, Buffalo (NCB), a hydraulic model investigation was conducted by the U. S. Army Engineer Waterways Experiment Station (WES) to:

a. Determine wave and current conditions in the western portion of the Lakefront Harbor as it now exists.

b. Determine the optimum design of proposed modifications at the west (main) entrance (i.e., breakwater removal, addition; dredging, etc.) with respect to the safe and efficient passage of 1,000-ft-long vessels for both fair-weather (waves to 4 ft and winds to 20 knots) and severe-weather (waves to 8 ft and winds to 30 knots) conditions.

c. Determine wave and/or current conditions that would be expected in the Lakefront Harbor as a result of modifications to the arrowhead (west) entrance.

d. Develop remedial plans, as necessary, for the alleviation of undesirable navigation, wave, and/or current conditions.

e. Determine if design modifications could be made to the proposed improvements that would reduce construction costs significantly and still provide adequate navigation conditions and wave protection.

## Wave-Height Criteria

13. For this study, NCB specified that for any of the various improvement plans to be acceptable, wave heights in the Lakefront Harbor should be equal to or less than those obtained for existing conditions. In addition, for some improvement plans (severe-weather conditions), maximum wave heights were not to exceed 3 ft in the existing entrance location for incident waves of 8 ft or less. (This criterion was established for those breakwater configurations in which the vessel had to nearly stop and make a turn at the existing entrance.)

## PART II: THE MODEL

### Design of Model

13. The Cleveland Harbor model (Figure 3) was constructed to an undistorted linear scale of 1:100, model to prototype. Scale selection was based on such factors as:

- a. Depth of water required in the model to prevent excessive bottom friction.
- b. Absolute size of model waves.
- c. Available shelter dimensions and area required for model construction.
- d. Efficiency of model operation.
- e. Available wave-generating and wave-measuring equipment.
- f. Model construction costs.

A geometrically undistorted model was necessary to ensure accurate reproduction of short-period wave and current patterns. Following selection of the linear scale, the model was designed and operated in accordance with Froude's model law (Stevens et al. 1942), and a specific weight scale ($\gamma_r$) of 1:1. The scale relations used for design and operation of the model were as follows:

| Characteristic | Dimension* | Model:Prototype Scale Relation |
|---|---|---|
| Length | L** | $L_r = 1:100$ |
| Area | $L^2$ | $A_r = L_r^2 = 1:10,000$ |
| Volume | $L^3$ | $\forall_r = L_r^3 = 1:1,000,000$ |
| Time | T | $T_r = L_r^{1/2} = 1:10$ |
| Velocity | L/T | $V_r = L_r^{1/2} = 1:10$ |
| Discharge | $L^3/T$ | $Q_r = L_r^{5/2} = 1:100,000$ |
| Force | F | $F_r = L_r^3\gamma_r = 1:1,000,000$ |

* Dimensions are in terms of force, length, and time.

** For convenience, symbols and unusual abbreviations are listed and defined in the Notation (Appendix B).

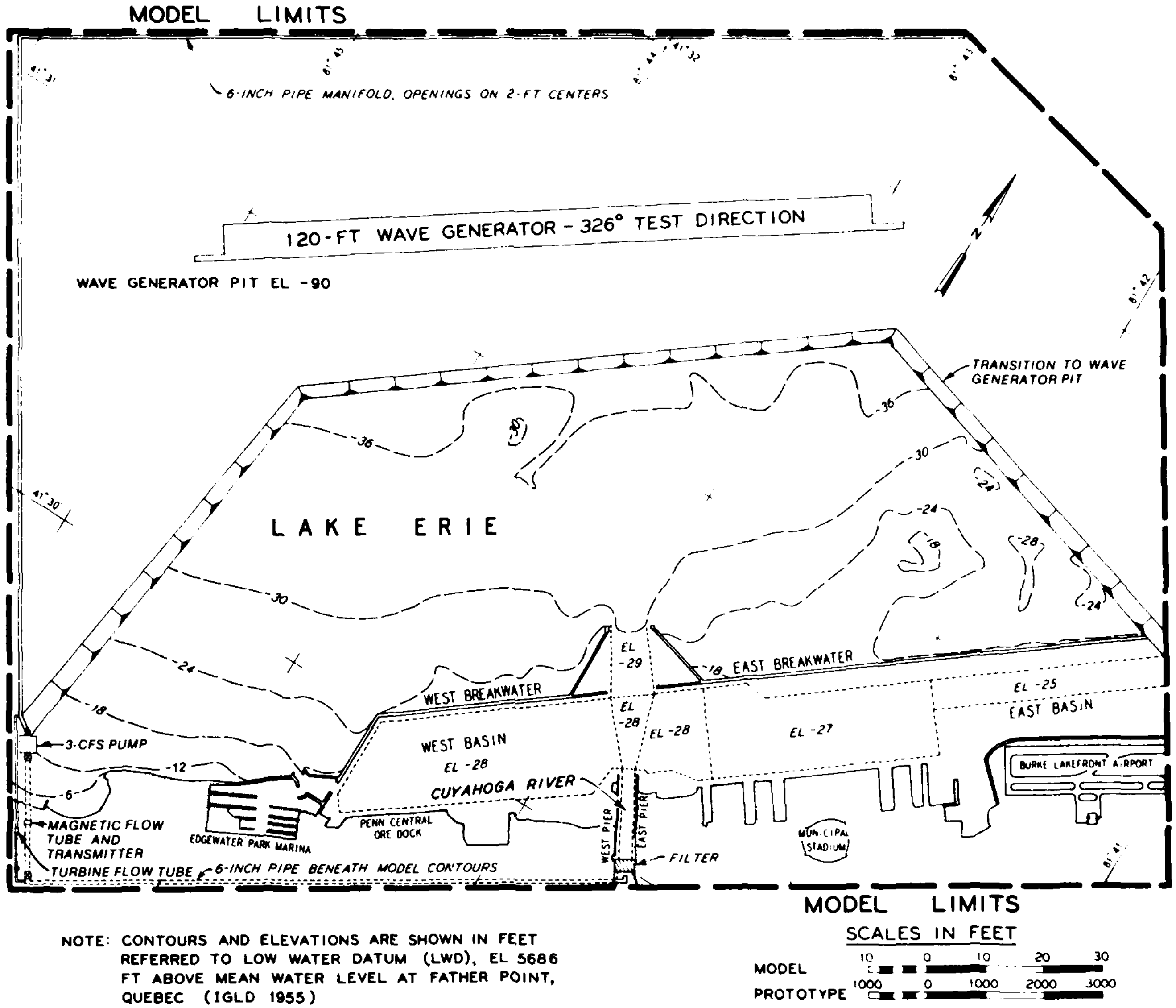


Figure 3. Model layout

14. The proposed improvement plans for the Cleveland Harbor model included the use of rubble-mound breakwaters and revetments. Some of the existing breakwaters also are rubble-mound structures. Experience and experimental research have shown that considerable wave energy passes through the interstices of this type of structure; thus the transmission and absorption of wave energy became a matter of concern in design of the 1:100-scale model. In small-scale hydraulic models, rubble-mound structures reflect relatively more and absorb or dissipate relatively less wave energy than geometrically similar prototype structures (LeMéhauté 1965). Also, the transmission of wave energy through the breakwater is relatively less for the small-scale model than for the prototype. Consequently, some adjustment in small-scale model rubble-mound structures is needed to ensure satisfactory reproduction of wave-reflection and wave-transmission characteristics. In past investigations at WES (Dai and Jackson 1966, Brasfeild and Ball 1967), this adjustment was made by determining the wave-energy transmission characteristics of the proposed structure in a two-dimensional model using a scale large enough to ensure negligible scale effects. A breakwater section then was developed for the small-scale, three-dimensional model that would provide essentially the same relative transmission of wave energy. Therefore, from previous findings for breakwaters and wave conditions similar to those at Cleveland, it was determined that a close approximation of the correct wave-energy transmission characteristics would be obtained by increasing the size of the rock used in the 1:100-scale model to approximately two times that required for geometric similarity. Accordingly, in constructing the breakwater structures in the Cleveland Harbor model, the rock sizes were computed by the linear scale, then multiplied by 2.0 to determine the actual sizes to be used in the model.

## The Model and Appurtenances

15. The model, which was molded in cement mortar, reproduced the west entrance to Cleveland Harbor opposite the mouth of the Cuyahoga

River; approximately 8,800 ft of the harbor shoreline to the east of this entrance, including the westernmost portion of Burke Lakefront Airport; the entire West Basin; Edgewater Marina; and underwater contours in Lake Erie to an offshore depth of -38 ft with a sloping transition to the wave generator pit elevation of -90 ft. The total area reproduced in the model was approximately 27,400 sq ft, representing about 9.8 square miles in the prototype. A general view of the model is shown in Figure 4. Vertical control for model construction was based on low water datum (lwd), el 568.6* ft above mean water level at Father Point, Quebec (International Great Lakes Datum 1955). Horizontal control was referenced to a local prototype grid system.

16. Model waves were generated by a 120-ft-long wave generator with a trapezoidal-shaped, vertical-motion plunger. The vertical movement of the plunger caused a periodic displacement of water incident to this motion. The length of the stroke and the frequency of the vertical motion were variable over the range necessary to generate waves with the required characteristics. In addition, the wave generator was mounted on retractable casters which enabled it to be positioned to generate waves from the required directions.

17. A water-circulating system (Figure 3) consisting of a 6-in. perforated-pipe water-intake manifold, a 3-cfs pump, and a magnetic flow tube and transmitter was used in the model to reproduce steady-state flows through the Cuyahoga River.

18. An Automated Data Acquisition and Control System (ADACS), designed and constructed at WES (Figure 5), was used to secure wave-height data at selected locations in the model. Basically, through the use of a minicomputer, ADACS recorded onto magnetic tape the electrical output of parallel-wire, resistance-type wave gages that measured the change in water-surface elevation with respect to time. The magnetic tape output of ADACS then was analyzed to obtain the wave-height data.

19. A 2-ft (horizontal) solid layer of fiber wave absorber was placed around the inside perimeter of the offshore lake boundary of the

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* All elevations (el) cited herein are in feet referred to low water datum (lwd).

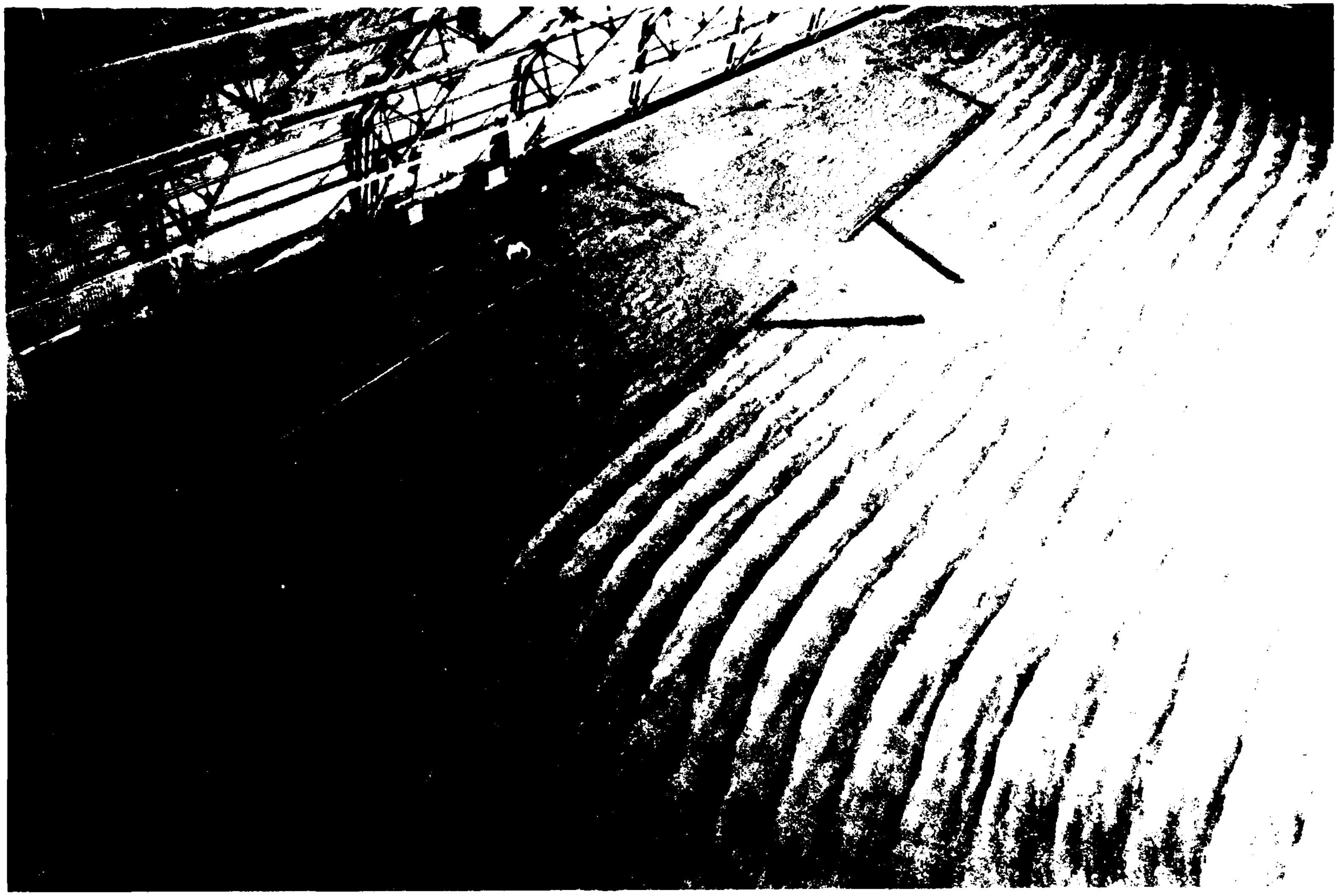

Figure 4. General view of model

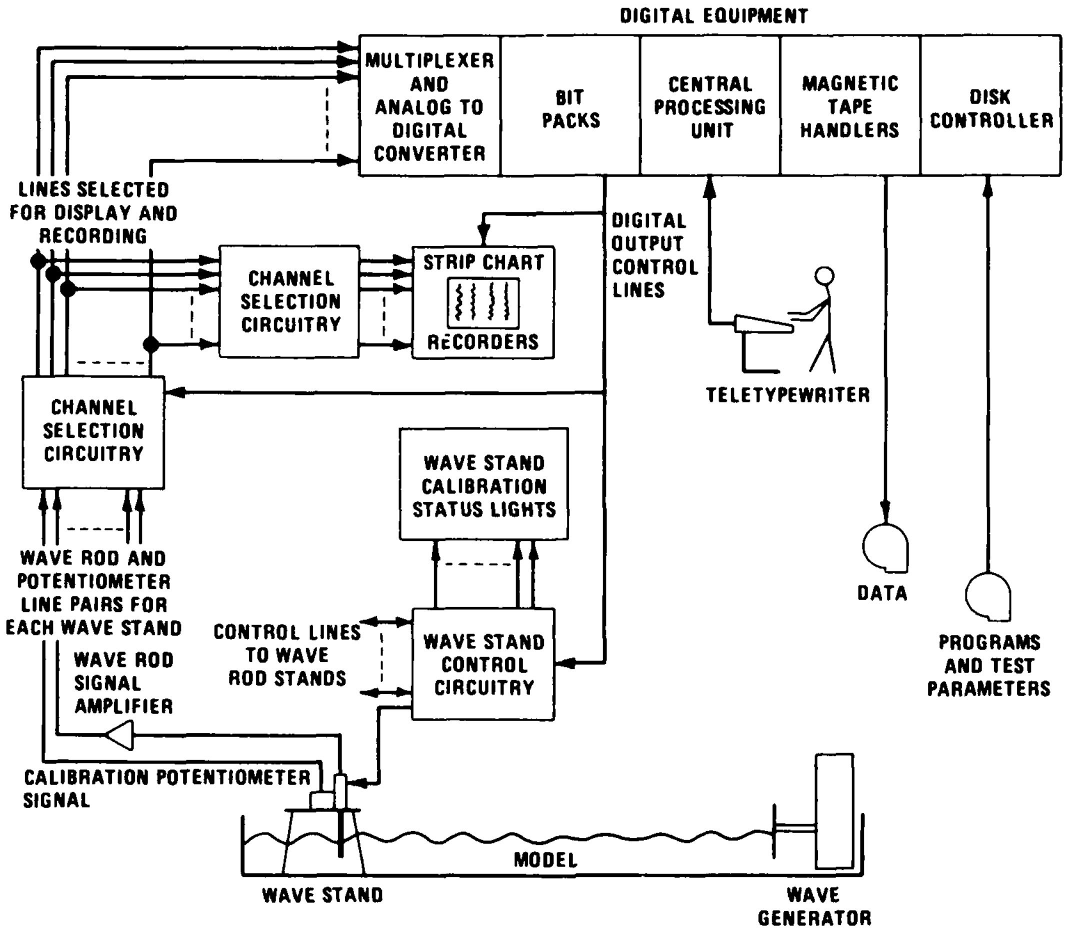


Figure 5. Automated Data Acquisition and Control System (ADACS)

model to damp any wave energy that might otherwise be reflected from the model walls. In addition, guide vanes were placed along the wave generator sides in the flat pit area to ensure proper formation of the wave train incident to the model contours.

20. A 10-ft-long model ore carrier (representing a 1,000-ft-long prototype vessel) was used in the model for maneuverability and navigation tests. This vessel (Figure 6) was remote-controlled and equipped with (a) twin engines that could be operated independently and move the carrier in forward or reverse directions; (b) rudders behind each main engine propeller that were controlled together; and (c) bow and stern thrusters that could be operated independently and move the carrier in the port (left) or starboard (right) directions. When fully loaded

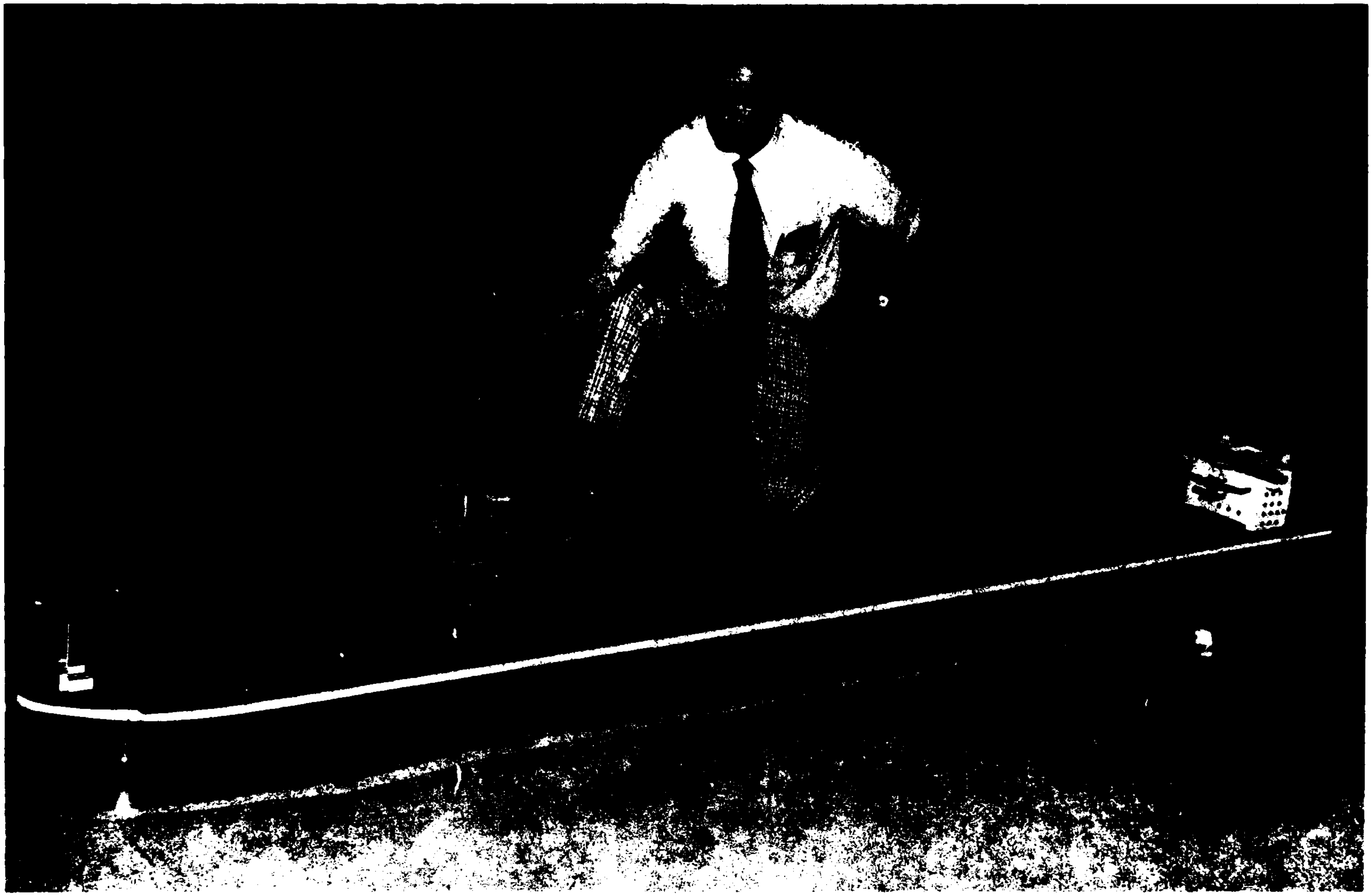

Figure 6. View of model ore carrier

(27.6-ft draft), the model ship was capable of traveling in slack water at a forward speed equivalent to 14 mph in the prototype and of moving to the port or starboard directions at a speed equivalent to 2 mph in the prototype.

21. For small-scale model ships, such as the model ore carrier used in the Cleveland Harbor model (1:100 scale), scale effects have an influence on maneuvering behavior; and thus, corrections are required to attain similarity of model to prototype characteristics. To obtain model ship speeds corresponding to those of the prototype vessel, in accordance with Froude's model law, the propeller revolutions required resulted in higher propeller jet velocities, causing increased rudder forces and a more responsive steering behavior of the model ship as compared with the prototype. As determined from Hoppe (1971) and an ongoing WES Civil Works Research and Development work unit, "Channel Dimensions and Alignment for Safe and Efficient Navigation," the 45-deg maximum rudder angles of the model ore carrier were reduced to a maximum of 30 deg to compensate for scale effects, thus making model steering characteristics similar to those of the prototype vessel.

22. An erratic wind field was reproduced, as in past WES investigations (Housley 1967, Bobb 1972), during the conduct of some of the ship navigation tests by placing large box fans on stands in the model. Wind forces against the prototype ship were calculated for various prototype wind velocities using Isherwood's (1971) equation:

$$F_w = C_y (1/2)(\rho)(V_s)^2 (A_s)$$

where

$F_w$ = wind force

$C_y$ = wind force coefficient factor

$\rho$ = density of air

$V_s$ = wind speed

$A_s$ = lateral area of ship

A plot of wind force versus wind velocity, as determined by this equation, is shown in Figure 7. The fans used in the model were independently calibrated by measuring the force on the ship model at various distances from each fan. Therefore, the distance the fans were placed from the vessel's path as it entered the harbor governed the force against the ship model. This model force correlated to a calculated prototype force for a specified wind speed.

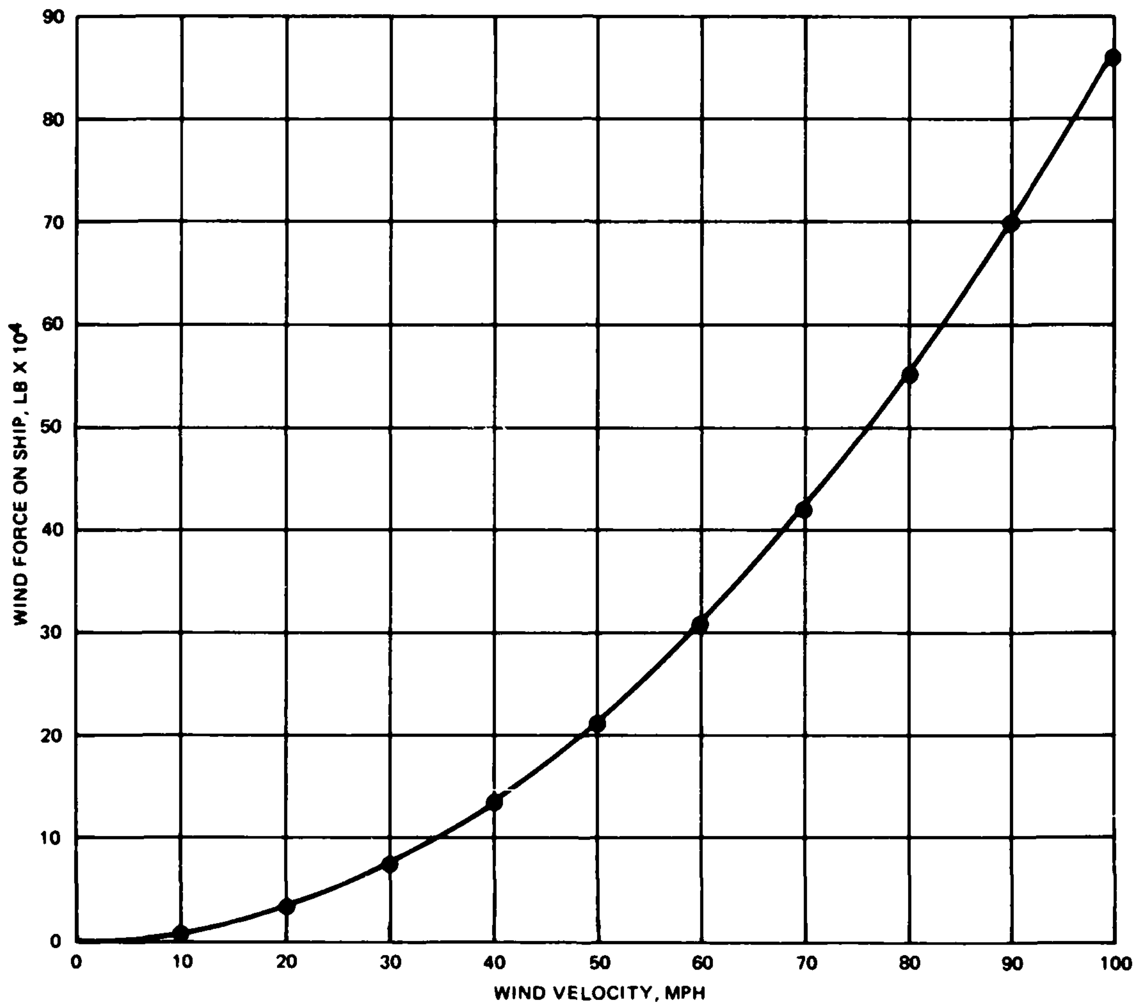


Figure 7. Wind force versus wind velocity

# PART III: TEST CONDITIONS AND PROCEDURES

## Selection of Test Conditions

23. Still-water levels (swl's) for harbor wave action models are selected so that the various wave-induced phenomena that are dependent on water depths are accurately reproduced in the model. These phenomena include the refraction of waves in the harbor area, the overtopping of harbor structures by the waves, the reflection of wave energy from harbor structures, and the transmission of wave energy through porous structures.

24. Water levels of the Great Lakes fluctuate from year to year and from month to month. Also, at any given location, the water level can vary from day to day and from hour to hour. Continuous records of the levels of the Great Lakes, tabulated since 1860, indicate that the usual pattern of seasonal variations of water levels consists of highs in summer and lows in late winter. The highest and lowest monthly average levels in Lake Erie usually occur in June and February, respectively. During the period of record (1860-1981), the average lake level of Lake Erie was +1.8 ft for the entire year and +2.1 ft for the ice-free period (April through November). The highest one-month average level of +4.9 ft occurred in June 1973, and the lowest one-month average level of -1.1 ft occurred in February 1936 (Saville 1953). The seasonal variation in the mean monthly level of Lake Erie usually ranges between 1.0 and 2.0 ft, with an average variation of 1.6 ft.

25. Seasonal and longer variations in the levels of the Great Lakes are caused by variations in precipitation and other factors that affect the actual quantities of water in the lakes. Wind tides and seiches are relatively short-period fluctuations caused by the tractive force of wind blowing over the water surface and differential barometric pressures, and are superimposed on the longer period variations in lake level. Large short-period rises in local water level are associated with the most severe storms, which generally occur in the winter when the lake level is usually low; therefore the probability that a high

lake level and large wind tide or seiche will occur simultaneously is relatively small.

26. The following lake levels were selected by NCB for use during model testing:

- a. Low level = 0.0 ft lwd (mean lake level for the first quarter (Jan-Mar) equaled or exceeded 95 percent of time).
- b. Mean level = +2.6 ft lwd (2nd and 3rd quarter mean lake level (Apr-Sep) equaled or exceeded 50 percent of the time).
- c. High level = +4.8 ft lwd (el +4.4 ft which is the monthly mean for the month of June equaled or exceeded 5 percent of the time plus a 0.4-ft setup which is the average 1-year recurrence setup for the months of May and June).

### Factors influencing selection of test wave characteristics

27. In planning the testing program for a model investigation of harbor wave-action problems, it is necessary to select dimensions and directions for the test waves that will allow a realistic test of proposed improvement plans and an accurate evaluation of the elements of the various proposals. Surface-wind waves are generated primarily by the interactions between tangential stresses of wind flowing over water, resonance between the water surface and atmospheric turbulence, and interactions between individual wave components. The height and period of the maximum wave that can be generated by a given storm depend on the wind speed, the length of time that wind of a given speed continues to blow, and the water distance (fetch) over which the wind blows. Selection of test wave conditions entails evaluation of such factors as:

- a. The fetch and decay distances (the latter being the distance over which waves travel after leaving the generating area) for various directions from which waves can attack the problem area.
- b. The frequency of occurrence and duration of storm winds from the different directions.
- c. The alignment, size, and relative geographic position of the navigation entrance to the harbor.
- d. The alignments, lengths, and locations of the various reflecting surfaces inside the harbor.

e. The refraction of waves caused by differentials in depth in the area lakeward of the harbor, which may create either a concentration or a diffusion of wave energy at the harbor site.

## Wave refraction

28. When wind waves move into water of gradually decreasing depth, transformations take place in all wave characteristics except wave period (to the first order of approximation). The most important transformations with respect to the selection of test wave characteristics are the changes in wave height and direction of travel due to the phenomenon referred to as wave refraction. The change in wave height and direction can be determined by plotting refraction diagrams and calculating refraction coefficients. These diagrams are constructed by plotting the position of wave orthogonals (lines drawn perpendicular to wave crests) from deep water into shallow water. If it is assumed that the waves do not break and that there is no lateral flow of energy along the wave crest, the ratio between the wave height in deep water ($H_o$) and the wave height at any point in shallow water (H) is inversely proportional to the square root of the ratio of the corresponding orthogonal spacings ($b_o$ and b), or $H/H_o = K_s(b_o/b)^{1/2}$. The quantity $(b_o/b)^{1/2}$ is the refraction coefficient, $K_r$ ; $K_s$ is the shoaling coefficient. Thus, the refraction coefficient multiplied by the shoaling coefficient gives a conversion factor for transfer of deepwater wave heights to shallow-water values. The shoaling coefficient, a function of wavelength and water depth, can be obtained from USACERC (1977). For this study, refraction diagrams were prepared for representative wave periods from the critical directions of approach using computer facilities at WES and are detailed in Appendix A.

## Prototype wave data and selection of test waves

29. Measured prototype wave data on which a comprehensive statistical analysis of wave conditions could be based were unavailable for the Cleveland Harbor area. However, statistical deepwater wave hindcast data representative of this area were obtained from Resio and Vincent (1976a), shoreline grid point 10. The numerical wind and wave models

used to produce this data are described in Resio and Vincent (1976b, 1977a, 1977b, and 1978). Resio and Vincent (1976a) cover deepwater waves approaching from three angular sectors at the site (Figure 8). Table 1 gives the significant wave heights for all approach angles and seasons combined for recurrence intervals of 5, 10, 20, 50, and 100 years. Table 2 shows significant wave period by angle class and wave height. The characteristics of most waves used during model testing were representative of wave conditions occurring during the navigation

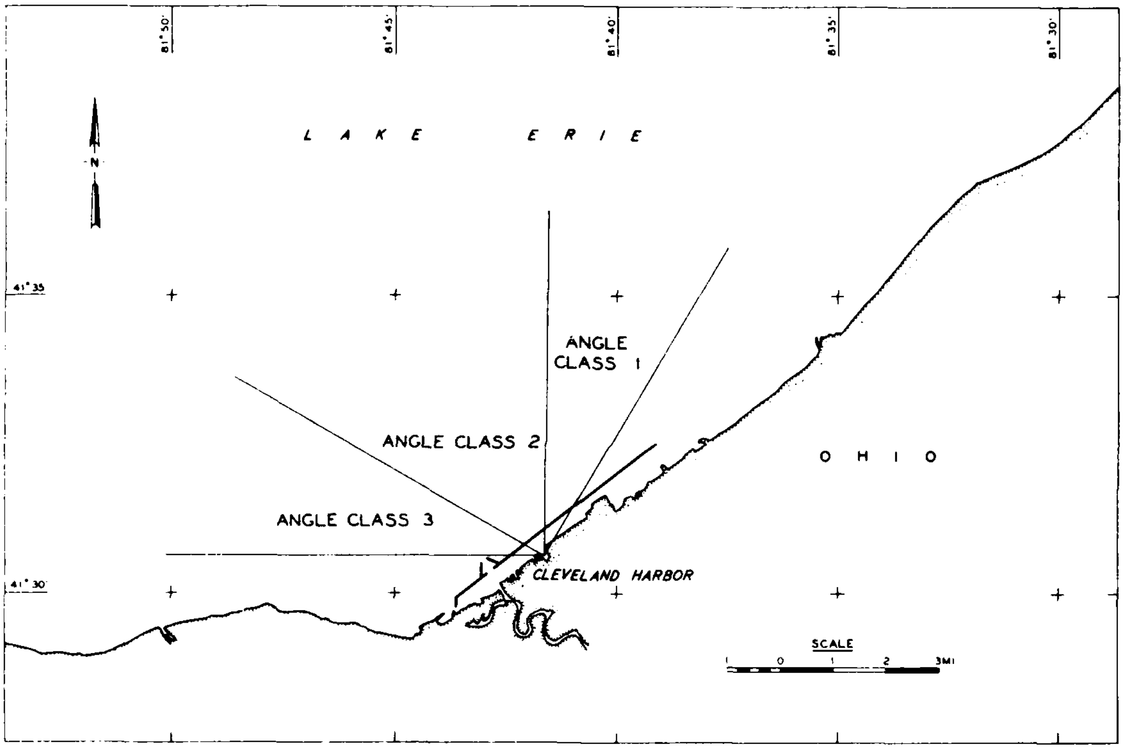


Figure 8. Wave hindcast angle classes

season (spring, summer, and fall). In addition, maximum wave heights for the winter season (20- and 100-year recurrence intervals) were tested to aid in design of the proposed breakwaters. Model test waves were selected from Tables 1 and 2 and converted to shallow-water values by application of refraction and shoaling coefficients as shown in the following tabulation:

| Deepwater Direction | Shallow-Water Azimuth, deg | Wave Period sec | Deepwater Wave Height ft | Shallow-Water Wave Height ft | Recurrence Interval years (season)* |
|---|---|---|---|---|---|
| West | 279 | 6 | 4.7 | 3.9 | 1 (SP) |
| | | 7 | 6.9 | 5.5 | 5 (SP) |
| | | 8 | 8.9 | 6.6 | 20 (SP) |
| | | 9 | 11.2 | 8.1 | 20 (F) |
| | | 9 | 6.0 | 4.3 | |
| | | | 12.1 | 8.6 | 20 (W) |
| | | 10 | 13.8 | 9.2 | 100 (W) |
| NW and NNW | 326 | 6 | 5.6 | 5.6 | 5 (SU) |
| | | 7 | 8.2 | 8.0 | 20 (SP) |
| | | 8 | 6.0 | 5.5 | |
| | | | 11.2 | 10.3 | 5 (W) |
| | | 8.5 | 11.8 | 10.7 | 20 (F) |
| | | 9 | 7.0 | 6.2 | |
| | | | 13.4 | 11.9 | 20 (W) |
| | | 10 | 15.7 | 13.7 | 100 (W) |
| NNE | 17 | 6 | 4.9 | 4.7 | 5 (SU) |
| | | 7 | 8.2 | 7.3 | 20 (SU) |
| | | 8 | 10.5 | 8.9 | 20 (F) |
| | | 8 | 6.0 | 5.1 | |
| | | | 11.5 | 9.8 | 20 (W) |
| | | 9.5 | 15.1 | 12.2 | 100 (W) |

* SU - summer, SP - spring, F - fall, and W - winter seasons.

The shallow-water wave directions were taken to be the average directions of the refracted waves for the significant wave periods noted from each deepwater direction.

River discharges

30. River discharges of 800 and 8,000 cfs were selected for use during model testing. The 800-cfs discharge represents a long-term average flow and was used for all model test plans. The 8,000-cfs river discharge represents a discharge with a 1-year recurrence interval and was used in addition to the 800-cfs discharge for existing conditions and the more promising improvement plans.

Wind conditions

31. During the conduct of some of the navigation tests, various wind conditions were simulated. Winds ranging from 23 to 34.5 mph (20 to 30 knots respectively) were generated, in most cases, from

approximately 235 or 55 deg. These directions were perpendicular to the ship's path as it entered the harbor and resulted in maximum set (drift) to the east and west, respectively. In some instances, winds were reproduced from 326 deg resulting in maximum set of the vessel to the south toward the existing west breakwater.

## Analysis of Model Data

32. The relative merits of the various plans tested were evaluated by:

- a. Comparison of navigation tests of the model ore carrier through the structures at the entrance.
- b. Comparison of wave heights at selected locations in the Lakefront Harbor.
- c. Comparison of wave-induced current patterns and magnitudes.
- d. Visual observations and wave pattern photographs.

In analyzing the wave-height data, the average height of the highest one-third of the waves recorded at each gage location was computed. Computed wave heights then were adjusted to compensate for excessive model wave-height attenuation due to viscous bottom friction by application of Keulegan's equation (Keulegan 1950). From this equation, reduction of wave heights in the model (relative to the prototype) can be calculated as a function of water depth, width of wave front, wave period, water viscosity, and distance of wave travel. Wave-induced current magnitudes were obtained by timing the progress of an injected dye tracer relative to a thin graduated scale placed on the model floor.

# PART IV: TESTS AND RESULTS

## The Tests

### Existing conditions

33. Before the conduct of tests of the various improvement plans, comprehensive tests were conducted for existing conditions. Wave-height data were obtained at various locations in the harbor (Plate 1) for the test waves listed in paragraph 29. Wave-induced current patterns and magnitudes, wave pattern photographs, and movie footage were secured for representative test waves from the three test directions. In addition, ship navigation tests were conducted for various wave and wind conditions.

34. Prior to the conduct of navigation tests, ship speeds, etc., were calibrated to correspond to prototype conditions. CAPT William J. McSweeney, a retired vessel master of the 1,000-ft-long M/V Mesabi Miner owned by Interlake Steamship Company, visited WES and assisted with the ship navigation tests. Initially, CAPT McSweeney familiarized himself with ship model operation, controls, etc. Ship modeling characteristics which he felt did not correspond to prototype characteristics were corrected (i.e., thrusters too responsive, excessive roll, etc.). After these modifications were made to the model ship, CAPT McSweeney felt that the maneuverability of the model was realistic, compared with that of the prototype vessel, under various wind and wave conditions during navigation and docking procedures.

### Improvement plans

35. Model tests were conducted for 27 test plan variations for fair-weather conditions and 26 test plan variations for severe-weather conditions. Fair-weather conditions were considered as those with wave heights of 4 ft and less and wind speeds of 23 mph (20 knots) and less; and test plan variations for these conditions consisted of modifications at the west entrance including spur breakwater removal, dredging, raising and/or sealing of the existing arrowhead breakwaters, and breakwater extensions originating at the lakeward ends of the arrowhead breakwaters.

Severe-weather conditions were characterized as those with wave heights up to 8 ft and wind speeds up to 34.5 mph (30 knots); and test plan variations for these conditions involved modifications at the west entrance consisting of spur breakwater removal, dredging, removal and/or extensions of the existing arrowhead structures, revetments, new offshore east and/or west breakwaters, raising and/or sealing of various structures, and connecting of the new breakwaters to the existing structures. Wave heights, ship navigation characteristics, wave-induced current patterns and magnitudes, wave pattern photographs, and/or model movie footage were obtained for various improvement plans. Brief descriptions of the test plans are presented in the following subparagraphs; dimensional details are presented in Plates 2-20.

- a. Fair-Weather (FW) Plan 1 (Plate 2) consisted of removal of 200 ft of the existing west spur breakwater and 100 ft of the existing east spur breakwater. The entrance channel width was increased in areas where the spur breakwaters were removed and deepened to 30 ft.
- b. FW Plan 1A (Plate 2) entailed the elements of FW Plan 1 with an additional 100 ft removed from both the west and east spurs.
- c. FW Plan 1B (Plate 2) involved the elements of FW Plan 1 with an additional 200 ft removed from both the west and east spurs.
- d. FW Plan 1C (Plate 2) consisted of the elements of FW Plan 1 with an additional 300 ft removed from both the west and east spurs.
- e. FW Plan 2 (Plate 3) entailed the elements of FW Plan 1, but the east and west arrowhead breakwaters were raised and sealed to prevent wave overtopping and/or transmission through these structures.
- f. FW Plan 2A (Plate 3) consisted of the elements of FW Plan 1A but the east and west arrowhead breakwater structures were raised and sealed.
- g. FW Plan 2B (Plate 3) involved the elements of FW Plan 1B but the east and west arrowhead breakwaters were raised and sealed.
- h. FW Plan 2C (Plate 3) entailed the elements of FW Plan 1C but the east and west arrowhead breakwater structures were raised and sealed.
- i. FW Plan 3 (Plate 4) involved the elements of FW Plan 1A with a 300-ft-long breakwater extension at the lakeward

end of the west arrowhead. This new breakwater cross section was the same as the existing arrowhead structure.

j. FW Plan 3A (Plate 4) consisted of the elements of FW Plan 1A with a 400-ft-long breakwater extension at the lakeward end of the west arrowhead.

k. FW Plan 3B (Plate 4) entailed the elements of FW Plan 1A with a 600-ft-long breakwater extension at the lakeward end of the west arrowhead.

l. FW Plan 3C (Plate 4) involved the elements of FW Plan 1A with an 800-ft-long extension at the lakeward end of the west arrowhead.

m. FW Plan 3D (Plate 4) included the elements of FW Plan 1A with a 1,000-ft-long extension at the lakeward end of the west arrowhead.

n. FW Plan 4 (Plate 5) consisted of the elements of FW Plan 3A but the west arrowhead breakwater was raised and sealed.

o. FW Plan 4A (Plate 5) entailed the elements of FW Plan 3A but the west arrowhead and the 400-ft-long breakwater extension were raised and sealed.

p. FW Plan 4B (Plate 5) involved the elements of FW Plan 3A but the 400-ft-long breakwater extension was raised and sealed.

q. FW Plan 4C (Plate 5) consisted of the elements of FW Plan 3 but the west arrowhead breakwater was raised and sealed.

r. FW Plan 4D (Plate 6) entailed the elements of FW Plan 4C with a 300-ft-long breakwater extension at the lakeward end of the east arrowhead breakwater parallel to the new west extension.

s. FW Plan 4E (Plate 6) included the elements of FW Plan 4D but the east arrowhead breakwater was raised and sealed.

t. FW Plan 5 (Plate 7) consisted of the elements of FW Plan 4D with the sealed west arrowhead breakwater installed with a crest elevation of +16 ft.

u. FW Plan 5A (Plate 7) involved the elements of FW Plan 4D with the sealed west arrowhead breakwater installed with a crest elevation of +14 ft.

v. FW Plan 5B (Plate 7) entailed the elements of FW Plan 4D with the sealed west arrowhead breakwater installed with a crest elevation of +12 ft.

w. FW Plan 5C (Plate 7) included the elements of FW Plan 4D with the sealed west arrowhead breakwater installed with a crest elevation of +10 ft.

x. FW Plan 5D (Plate 7) involved the elements of FW Plan 4D with the sealed west arrowhead breakwater installed with a crest elevation of +8 ft.

y. FW Plan 5E (Plate 7) consisted of the elements of FW Plan 4D with a nonsealed west arrowhead breakwater installed with a crest elevation of +10 ft.

z. FW Plan 5F (Plate 7) entailed the elements of FW Plan 4D with a nonsealed west arrowhead breakwater installed with a crest elevation of +12 ft.

aa. FW Plan 5G (Plate 7) involved the elements of FW Plan 4D with a nonsealed west arrowhead breakwater installed with a crest elevation of +14 ft.

bb. Severe-Weather (SW) Plan 6 (Plate 8) entailed the removal of 600 ft of the west arrowhead breakwater, 300 ft of the existing west spur, and 200 ft of the existing east spur. Also included were a 900-ft-wide, 32-ft-deep approach channel extending approximately 3,000 ft lakeward and new offshore east and west breakwaters. The new east and west breakwaters were 3,000 and 1,500 ft long, respectively, and were installed at a crest elevation of +8 ft.

cc. SW Plan 6A (Plate 8) involved the elements of SW Plan 6 with a 200-ft-long extension on the shoreward end of the east breakwater.

dd. SW Plan 6B (Plate 8) consisted of the elements of SW Plan 6 with a 300-ft-long extension on the shoreward end of the east breakwater.

ee. SW Plan 6C (Plate 8) entailed the elements of SW Plan 6 but 500 ft on the shoreward end of the east breakwater was raised to a crest elevation of +10 ft.

ff. SW Plan 7 (Plate 8) included the elements of SW Plan 6C with a revetment installed along the lakeward side of the existing west breakwater at an elevation of +12 ft.

gg. SW Plan 8 (Plate 9) consisted of the elements of SW Plan 6C but the new offshore west breakwater was extended shoreward to the existing west breakwater. The entire structure was raised and sealed to prevent wave overtopping and/or transmission through the breakwater.

hh. SW Plan 9 (Plate 10) entailed the elements of SW Plan 6C, but the 900-ft-wide channel was reduced to 600 ft and the west offshore breakwater reoriented slightly.

ii. SW Plan 9A (Plate 10) involved the elements of SW Plan 9, but the offshore west breakwater was extended to the existing west breakwater and the entire structure was raised and sealed.

jj. SW Plan 10 (Plate 11) consisted of the elements of SW Plan 6, but the offshore east and west breakwaters were reoriented resulting in a 600-ft-wide entrance southwesterly of the SW Plan 6 entrance.

kk. SW Plan 10A (Plate 11) entailed the elements of SW Plan 10, but the new offshore west breakwater was extended shoreward to the existing west breakwater. The entire west structure was raised and sealed to prevent wave overtopping and/or transmission through the breakwater.

ll. SW Plan 11 (Plate 12) involved the removal of 600 ft of the existing west arrowhead breakwater, 300 ft of the west spur, and 200 ft of the east spur. Also included were a 900-ft-wide entrance channel and a new east breakwater (crest el +8 ft). The initial 1,000 ft of this new structure originated at the lakeward end of the existing arrowhead breakwater and extended lakeward. From this point the new structure extended 3,000 ft westerly, parallel to the existing west breakwater.

mm. SW Plan 12 (Plate 13) consisted of the elements of SW Plan 11 except the lakeward 3,000 ft of the new east breakwater was reoriented and installed on about a 250-deg azimuth.

nn. SW Plan 12A (Plate 13) entailed the elements of SW Plan 12 with a 500-ft-long offshore west breakwater (crest el +8 ft) installed, resulting in a 600-ft-wide entrance channel.

oo. SW Plan 12B (Plate 13) involved the elements of SW Plan 12A with a 400-ft-long extension (crest el +8 ft) of the west arrowhead breakwater installed parallel to the entrance channel.

pp. SW Plan 12C (Plate 13) consisted of the elements of SW Plan 12B but the 500-ft-long offshore west breakwater was removed.

qq. SW Plan 12D (Plate 14) entailed the elements of SW Plan 12C but the entire west arrowhead breakwater crest elevation was raised to +14 ft.

rr. SW Plan 12E (Plate 14) involved the elements of SW Plan 12D with the 500-ft-long offshore west breakwater of SW Plan 12A reinstalled in the model. This structure was raised and sealed to prevent wave overtopping and/or transmission through the breakwater.

ss. SW Plan 13 (Plate 15) consisted of the elements of SW Plan 12 except the lakeward 3,000 ft of the new east breakwater was installed on about a 260-deg azimuth. Also included was a 400-ft-long extension (crest el +8 ft) of the west arrowhead breakwater installed parallel to the entrance channel.

tt. SW Plan 13A (Plate 15) entailed the elements of SW Plan 13 with a 500-ft-long offshore west breakwater (crest el +8 ft) installed resulting in a 600-ft-wide entrance channel.

uu. SW Plan 13B (Plate 15) consisted of the elements of SW Plan 13A but the new offshore west breakwater was extended shoreward to the existing west breakwater. The entire west structure was raised and sealed to prevent wave overtopping and/or transmission through the breakwater.

vv. SW Plan 13C (Plate 16) included the elements of SW Plan 13 with a 1,000-ft-long offshore west breakwater (crest el +8 ft) installed approximately 2,000 ft westerly of the lakeward head of the new east breakwater.

ww. SW Plan 13D (Plate 17) involved the elements of SW Plan 13 but the extension of the west arrowhead breakwater was increased to 1,000 ft in length and oriented on an azimuth of about 300 deg.

xx. SW Plan 14 (Plate 18) consisted of the elements of SW Plan 13 but the 3,000-ft-long lakeward section of the new east breakwater was oriented approximately 5 deg shoreward (on about a 255-deg azimuth).

yy. SW Plan 14A (Plate 18) entailed the elements of SW Plan 14 but the west arrowhead breakwater extension was increased to 1,000 ft in length and oriented on an azimuth of about 295 deg.

zz. SW Plan 15 (Plate 19) involved the elements of SW Plan 14A but the new east breakwater originating at the head of the east arrowhead was reoriented and extended about 1,600 ft lakeward on an azimuth of 290 deg. From this point, the structure extended approximately 2,400 ft on the 255-deg azimuth.

aaa. SW Plan 16 (Plate 20) consisted of the removal of 300 ft of the existing west spur breakwater and 200 ft of the existing east spur breakwater. Included were 1,000-ft-long parallel breakwater extensions (crest el +8 ft) originating at the lakeward ends of the existing east and west arrowhead structures.

Wave-height tests

36. Wave-height tests were conducted for the various improvement plans using test waves from one or more of the test directions listed in paragraph 29. Tests involving certain proposed improvement plans were limited to the most critical direction of wave approach. However, major plans of improvement were tested comprehensively for test waves from all three directions (i.e., 17, 326, and 279 deg). Wave gage locations for each improvement plan are shown in Plates 2-20.

Navigation tests

37. Navigation tests initially were conducted for the incremental removal of the east and west breakwater spurs (Fair-Weather Plans 1-1C) for various wave and wind conditions. After this, navigation tests were conducted only for the more promising improvement plans (i.e., plans that satisfied the established wave-height criteria).

Wave-induced current pattern and magnitude tests

38. Wave-induced current patterns and magnitudes were determined at selected locations by timing the progress of a dye tracer relative to a known distance on the model floor. These tests were conducted for major improvement plans using representative test waves from all three test directions.

Movie

39. Model movie footage was secured and forwarded to NCB for use in public meetings, briefings, etc. Included in the movie footage were the following:

a. Appurtenances used in the model.

b. Methods of obtaining wave heights and wave-induced current patterns and magnitudes.

c. Various waves approaching the west entrance for existing conditions and the major improvement plans.

d. Model vessel capabilities.

e. Navigation of model ore carrier for various wave conditions with the major improvement plans installed.

f. Calibration of wind field.

## Test Results

40. In evaluating test results, the relative merits of various plans were based on an analysis of measured wave heights, wave-induced current patterns and magnitudes, and/or the relative ease of ship navigation through the entrance. Model wave heights (significant wave height or $H_{1/3}$) were tabulated to show measured values at selected locations. Wave-induced current patterns and magnitudes were superimposed on wave pattern photographs for the corresponding plan and wave condition tested.

### Existing conditions

41. Wave-height measurements obtained for existing conditions using the 0.0, +2.6, and +4.8 ft swl's with both the 800- and 8,000-cfs Cuyahoga River discharges are presented in Tables 3-8. For the 0.0-ft swl, maximum wave heights were 22.3 ft in the arrowhead entrance (gages 14-16 in Plate 1) for 10-sec, 13.7-ft test waves from 326 deg with the 8,000-cfs discharge, and 4.3 ft at the Penn Central Ore Dock (gages 1-4) for 10-sec, 13.7-ft test waves from 326 deg with the 800-cfs discharge. For the +2.6 ft swl, maximum wave heights were 25.0 ft in the arrowhead entrance for 10-sec, 13.7-ft test waves from 326 deg with the 8,000-cfs river discharge, and 8.1 ft at the Penn Central Ore Dock for 10-sec, 13.7-ft test waves from 326 deg with the 800-cfs discharge. For the +4.8 ft swl, maximum wave heights were 26.2 ft in the arrowhead entrance for 10-sec, 13.7-ft test waves from 326 deg with the 800-cfs river discharge, and 10.9 ft at the Penn Central Ore Dock for 9.5-sec, 12.2-ft test waves from 17 deg with the 8,000-cfs discharge. In general, the larger test waves from each direction (particularly at the +4.8 ft swl) overtopped the west breakwater, the arrowhead breakwaters at the west entrance, the east and west spurs, and the east breakwater, transmitting more energy into the harbor and resulting in larger wave heights. The 326-deg test direction (waves approaching normal to the east and west breakwaters) proved, in most cases, to produce the worst wave conditions in the harbor. Cuyahoga River discharges tested (800 and 8,000 cfs) produced definite effects on waves in the harbor entrance; however,

there was no clear trend regarding which discharge produced larger wave heights. The river discharge, combined with lakeward flowing currents in the entrance due to wave overtopping of the breakwaters, resulted in peaking of waves in the entrance channel and wave heights were considerably larger than normally would be expected due to refraction and shoaling effects only.

42. Wave-induced current patterns and magnitudes secured for existing conditions using representative test waves for the various swl's and river discharges are presented in Photos 1-36. Maximum velocities obtained at various locations were as follows:

| Location | Maximum Velocity fps | Wave Direction deg | Test Wave | swl ft | River Discharge cfs |
|---|---|---|---|---|---|
| Area lakeward of east breakwater | 3.3 | 326 | 9 sec, 11.9 ft | 0.0 | 800 |
| Harbor area protected by east breakwater | 1.4<br>1.4 | 326<br>326 | 9 sec, 11.9 ft<br>9 sec, 11.9 ft | 0.0<br>0.0 | 800<br>8,000 |
| Area between east arrowhead and east spur | 3.3 | 17 | 8 sec, 9.8 ft | +4.8 | 8,000 |
| Cuyahoga River | 1.3 | 279 | 9 sec, 8.6 ft | 0.0 | 8,000 |
| Entrance channel | 4.5 | 326 | 9 sec, 11.9 ft | +4.8 | 800 |
| Area between west arrowhead and west spur | 3.0 | 326 | 9 sec, 11.9 ft | +4.8 | 8,000 |
| Area along Penn Central Ore Dock | 3.6 | 326 | 9 sec, 11.9 ft | +4.8 | 800 |
| Remaining harbor area protected by west breakwater | 2.8 | 326 | 9 sec, 11.9 ft | +4.8 | 800 |
| Area lakeward of west breakwater | 2.9 | 279 | 9 sec, 8.6 ft | +4.8 | 8,000 |

Typical wave patterns for existing conditions also are shown in Photos 1-36.

43. Navigation tests were conducted with existing conditions installed for test waves from 279, 326, and 17 deg (with 20-knot (23 mph) and 26-knot (30 mph) winds superimposed for some of the tests). Views of the model ship during operation are shown in Photos 37-43. It

was determined from these tests that the existing entrance was not safe and efficient with respect to the passage of 1,000-ft-long vessels even under fair-weather conditions (waves up to 4 ft and winds up to 20 knots (23 mph)).

## Improvement Plans

### Fair-weather conditions

44. The initial series of test plans (Fair-Weather Plans 1-5G) dealt with improvements at the west entrance for safe and efficient passage of 1,000-ft-long vessels during fair-weather conditions (waves up to 4 ft and winds up to 20 knots (23 mph)). For an improvement plan to be acceptable, however, wave heights in the Lakefront Harbor were to be equal to or less than those obtained for existing conditions (for corresponding wave conditions).

45. Results of wave-height tests for Fair-Weather Plans 1-1C and Fair-Weather Plans 2-2C for various test waves from 326 deg using the +2.6 ft swl and the 800-cfs Cuyahoga River discharge are presented in Tables 9 and 10. Maximum wave heights obtained for Fair-Weather Plans 1-1C in the main entrance (gages 14-16) were 24.1, 25.9, 23.9, and 22.8 ft, respectively; and maximum wave heights at the Penn Central Ore Dock (gages 1-4) were 6.3, 7.0, 5.6, and 6.8 ft, respectively. For Fair-Weather Plans 2-2C, maximum wave heights were 24.2, 24.1, 23.0, and 22.1 ft at the main entrance and 5.9, 7.7, 5.8, and 7.1 ft at the Penn Central Ore Dock, respectively. Raising and sealing the arrowhead breakwaters (Fair-Weather Plans 2-2C), in general, reduced wave heights slightly in the entrance and at the Cuyahoga River for these test conditions. Generally, wave heights in the remainder of the Lakefront Harbor were affected little by this change. Typical wave patterns obtained for Fair-Weather Plans 1-1C and 2-2C are shown in Photos 44-51.

46. Navigation tests were conducted for the incremental removal of the east and west spurs (Fair-Weather Plans 1-1C). It was determined from these tests that for the safe and efficient use of the west (main) entrance by 1,000-ft-long vessels during fair-weather conditions, the

east and west spur breakwaters should be reduced in length by a minimum of 200 ft and 300 ft, respectively (Fair-Weather Plan 1A). The removal of these spur lengths allowed the vessel master to begin his turns sooner while entering and leaving the harbor.

47. The removal of 200-ft and 300-ft lengths of the east and west breakwater spurs, respectively (Fair-Weather Plan 1A), resulted in increased wave heights in the Lakefront Harbor; therefore tests were required to develop a plan for alleviating these undesirable wave conditions. Results of wave-height tests for Fair-Weather Plans 1A, 2A, 3-3D, and 4-4C are presented in Table 11 for representative test waves from 279 deg. Table 12 shows wave-height measurements for Fair-Weather Plans 1A, 2A, 4D, and 4E for test waves from 17 deg and Fair-Weather Plan 4D for test waves from 326 deg. Comparisons of wave heights for existing conditions and various test plans for corresponding test conditions are shown in Tables 13-15 for the 279-, 17-, and 326-deg test directions for the +2.6 ft swl and the 800-cfs river discharge. For test waves from 279 deg, Fair-Weather Plan 4C (west arrowhead breakwater raised and sealed and a 300-ft-long extension of the west arrowhead breakwater) appeared to be the optimum plan tested. In general, wave heights in the Lakefront Harbor for Fair-Weather Plan 4C were equal to or less (in most cases) than those obtained for existing conditions. The addition of a 300-ft-long extension to the east arrowhead breakwater installed parallel to the west extension (Fair-Weather Plan 4D) appeared to be the optimum plan tested for waves from 17 and 326 deg. Again, wave heights in the Lakefront Harbor, in general, were equal to or less than those obtained for existing conditions for Fair-Weather Plan 4D, particularly for wave conditions with a 20-year or less recurrence interval. In some cases, for wave conditions with a 100-year recurrence interval at a particular gage location, wave heights may have increased slightly; but overall conditions in the Lakefront Harbor were generally calmer for Fair-Weather Plan 4D than for existing conditions for test waves from 17 and 326 deg. Typical wave patterns for Fair-Weather Plans 3-3D and 4-4E are shown in Photos 52-62.

48. Comprehensive wave-height tests were conducted for Fair-Weather

Plan 4D from all test directions using the 0.0, +2.6, and +4.8 ft swl's with the 800- and 8,000-cfs river discharges. Results of these tests are presented in Tables 16-21. For the 0.0-ft swl, maximum wave heights were 20.1 ft in the entrance (gages 14-16) and 3.1 ft at the Penn Central Ore Dock (gages 1-4) for 10-sec, 13.7-ft waves from 326 deg with the 8,000-cfs river discharge. For the +2.6 ft swl, maximum wave heights were 23.3 ft in the entrance and 6.6 ft at the Penn Central Ore Dock for 10-sec, 13.7-ft waves from 326 deg with the 800-cfs discharge. The +4.8 ft swl yielded maximum wave heights of 24.8 ft in the entrance for 9-sec, 11.9-ft waves from 326 deg with the 800-cfs discharge; and 9.0 ft at the Penn Central Ore Dock for 10-sec, 13.7-ft waves from 326 deg with the 800-cfs river discharge. A comparison of wave heights for Fair-Weather Plan 4D with those of existing conditions revealed that in general, wave heights in the Lakefront Harbor were equal to or less for Fair-Weather Plan 4D. For some wave conditions, wave heights increased slightly at a particular gage location, but overall conditions in the Lakefront Harbor were generally calmer for Fair-Weather Plan 4D than for existing conditions for test waves from all directions.

49. Wave-induced current patterns and magnitudes secured for Fair-Weather Plan 4D using representative test waves for the various swl's and river discharges are presented in Photos 63-98. Maximum velocities obtained at various locations were as follows:

| Location | Maximum Velocity fps | Wave Direction deg | Test Wave | swl ft | River Discharge cfs |
|---|---|---|---|---|---|
| Harbor area protected by east breakwater | 1.1 | 326 | 9 sec, 11.9 ft | +4.8 | 8,000 |
| Area between east arrowhead and east spur | 3.1 | 17 | 8 sec, 9.8 ft | +4.8 | 800 |
| Cuyahoga River | 1.3 | 326 | 6 sec, 5.6 ft | 0.0 | 8,000 |
| | 1.3 | 326 | 6 sec, 5.6 ft | +2.6 | 8,000 |
| Entrance channel | 4.3 | 326 | 9 sec, 11.9 ft | +4.8 | 8,000 |
| Area between west arrowhead and west spur | 2.2 | 326 | 9 sec, 11.9 ft | +4.8 | 8,000 |
| Harbor area protected by west breakwater | 3.1 | 279 | 9 sec, 8.6 ft | +4.8 | 800 |

Typical wave patterns obtained for Fair-Weather Plan 4D also are shown in Photos 63-98.

50. In instances for the preceding test plans where the arrowhead breakwaters were raised, the structures were installed at a +18 ft crest elevation and sealed to prevent wave overtopping and/or transmission. Wave-height tests were conducted for Fair-Weather Plans 5-5G to optimize the crest height of the west arrowhead breakwater of Fair-Weather Plan 4D. Results of these tests are presented in Table 22 where they are compared with existing conditions and Fair-Weather Plan 4D. Examination of these data reveals that a +10 ft sealed breakwater crest elevation (Fair-Weather Plan 5C) and a +14 ft unsealed breakwater elevation (Fair-Weather Plan 5G) were the optimum plans tested for the west arrowhead structure.

Severe-weather conditions

51. The next series of test plans (Severe-Weather Plans 6-16) dealt with improvements at the west entrance for the design for safe and efficient passage of 1,000-ft-long vessels during severe-weather conditions (waves up to 8 ft and winds up to 30 knots). For an improvement plan to be acceptable, however, wave heights in the Lakefront Harbor were to be equal to or less than those obtained for existing conditions (for corresponding wave conditions). In addition, for most severe-weather test plans (Severe-Weather Plans 6-15), wave heights at the existing entrance (gage 16) were not to exceed 3 ft for incident wave heights of 8 ft and less. These test plans involved configurations that required the vessel, during navigation, to slow down and make a sharp turn (with aid of the thrusters) in a starboard (right) direction to enter the existing entrance.

52. Wave-height tests conducted for Severe-Weather Plans 6-6C for representative test waves from 326, 17, and/or 279 deg, using the +2.6 ft and/or +4.8 ft swl's with the 800-cfs Cuyahoga River discharge are presented in Tables 23 and 24. For test waves from 326 deg, wave heights were within the established wave-height criteria for Severe-Weather Plan 6. For test waves from 17 deg, maximum wave heights obtained were 4.2, 3.6, 3.5, and 2.9 ft at the existing entrance (gage 16) for

Severe-Weather Plans 6-6C, respectively, for incident waves of 8 ft or less. For test waves from 279 deg, the established wave-height criteria were exceeded in the Lakefront Harbor (i.e., wave heights were greater than those obtained for existing conditions) and at the existing entrance (i.e., waves at gage 16 were greater than 3 ft for incident wave heights of 8 ft or less) for Severe-Weather Plan 6C for practically all the test waves using both the +2.6 and +4.8 ft swl's. Wave patterns secured for Severe-Weather Plans 6-6C are shown in Photos 99-110.

53. Wave-height tests conducted for Severe-Weather Plans 7, 8, 9, and 9A for test waves from 279 deg using the +2.6 and/or +4.8 ft swl's with the 800-cfs river discharge are presented in Tables 25 and 26. Maximum wave heights were 7.0, 6.1, 4.2, and 4.7 ft at the existing entrance (gage 16) for Severe-Weather Plans 7, 8, 9, and 9A, respectively (for incident waves of 8 ft or less). Each plan resulted in wave heights exceeding the 3-ft criterion at gage 16 for these 8-ft incident waves. In addition, wave heights in the Lakefront Harbor for corresponding wave conditions were generally greater than those obtained for existing conditions. Typical wave patterns obtained for Severe-Weather Plans 7-9A are shown in Photos 111-118.

54. Wave-height data obtained with Severe-Weather Plans 10, 10A, and 11 installed in the model using the +2.6 and/or +4.8 ft swl's for test waves from 279 deg with the 800-cfs river discharge are presented in Table 27. Maximum wave heights obtained were 5.2, 3.9, and 2.9 ft at the existing entrance (gage 16) for Severe-Weather Plans 10, 10A, and 11, respectively (for incident waves of 8 ft or less). The 3-ft wave-height criterion at gage 16 was satisfied only for Severe-Weather Plan 11. Wave heights inside the Lakefront Harbor, in general, were greater than those obtained for existing conditions for Severe-Weather Plans 10 and 10A and equal to or less than those obtained for existing conditions for Severe-Weather Plan 11. In some instances, with Severe-Weather Plan 11 installed, wave heights increased slightly at a particular gage location, but overall conditions in the Lakefront Harbor were generally comparable to those obtained for existing conditions. Typical wave patterns secured for Severe-Weather Plans 10, 10A, and 11 are shown in Photos 119-124.

55. Results of wave-height tests conducted for Severe-Weather Plans 12-12E for test waves from 279 deg using the +2.6 and/or +4.8 ft swl's with the 800-cfs river discharge are presented in Tables 28 and 29. Maximum wave heights obtained were 2.4, 2.0, 2.1, 2.4, 2.7, and 2.4 ft at the existing entrance (gage 16) for Severe-Weather Plans 12-12E, respectively (for incident waves of 8 ft or less). The 3-ft wave-height criterion in the entrance (gage 16) for these 8-ft incident waves was satisfied by all these test plans. Wave heights inside the Lakefront Harbor for Severe-Weather Plans 12 and 12A, in general, were greater than those obtained for existing conditions for corresponding wave conditions. In some cases, with Severe-Weather Plans 12B-12E installed, wave heights increased at a particular gage location, but overall conditions in the Lakefront Harbor were comparable to those obtained for existing conditions. Typical wave patterns obtained for Severe-Weather Plans 12-12E are shown in Photos 125-136.

56. Results of wave-height tests conducted for Severe-Weather Plans 13-13D using the +4.8 ft swl and Severe-Weather Plans 13D, 14, 14A, and 15 using the +2.6 ft swl are presented in Tables 30 and 31. Test waves were from 279 deg with the 800-cfs Cuyahoga River discharge. With the +4.8 ft swl, maximum wave heights obtained were 3.8, 4.3, 3.2, 2.7, and 2.2 ft at the existing entrance (gage 16) for Severe-Weather Plans 13-13D, respectively (for incident waves of 8 ft or less). For the +2.6 ft swl, maximum wave heights were 2.9, 2.5, 2.8, and 1.6 ft at the existing entrance for Severe-Weather Plans 13D, 14, 14A, and 15, respectively (for incident waves of 8 ft or less). The 3-ft wave-height criterion in the entrance (gage 16) for these 8-ft or less incident waves was satisfied by Severe-Weather Plans 13C, 13D, 14, 14A, and 15. In general, wave heights in the Lakefront Harbor (considering all wave conditions) were less for Severe-Weather Plan 15 than for the other test plans. Typical wave patterns obtained for Severe-Weather Plans 13-13D and Severe-Weather Plans 14 and 14A are shown in Photos 137-150.

57. Wave-height data obtained for Severe-Weather Plan 15 for test waves from 279, 326, and 17 deg using the +4.8 ft swl with the

800-cfs river discharge are presented in Table 32. Maximum wave heights obtained at the existing entrance (gage 16) were 1.4, 2.3, and 3.0 ft for the 279-, 326-, and 17-deg directions, respectively (for incident waves of 8 ft or less). In some instances, wave heights in the Lakefront Harbor increased slightly at a particular gage location, but overall wave conditions in the harbor for Severe-Weather Plan 15 were generally less than those previously obtained for existing conditions. Wave pattern photographs obtained for Severe-Weather Plan 15 for representative test waves from 279, 326, and 17 deg are shown in Photos 151-156.

58. Navigation tests were conducted for various severe-weather entrance configurations for incident test waves of 8 ft or less from 279, 326, and 17 deg. Winds of 30 knots (34.5 mph) were superimposed on waves during the conduct of some of these tests. Assisting with the navigation tests were CAPT W. J. McSweeney, retired vessel master formerly employed with Interlake Steamship Company; CAPT G. V. Chamberlain, retired vessel master formerly employed with Hanna Mining Company; and CAPT A. H. Haynes, active vessel master presently employed with American Steamship Company. All three vessel masters have had experience operating 1,000-ft-long vessels in the Great Lakes; and after familiarizing themselves with ship model operation, controls, etc., all felt confident that the maneuverability characteristics of the model ship were realistic, compared with those of the prototype, under various wave and wind conditions. It was determined from these tests that the Severe-Weather Plan 15 harbor configuration was optimum with respect to a severe-weather entrance oriented toward the west. The vessel's approach upon entry was somewhat parallel to shore, and slow speeds had to be maintained to make the turn into the harbor at the existing entrance. Due to the slow speeds, the vessel's maneuverability was decreased and some wave and wind conditions from 326 and 17 deg tended to set the stern toward the shore and the bow toward the new east breakwater as illustrated in Photo 157. It was felt that only the more experienced and skillful masters would be able to safely and efficiently enter the harbor for the worst wave and wind conditions, thus leaving a narrow margin of error for the average vessel master. After navigation

tests were conducted for numerous alternative entrance configurations, the vessel masters expressed a preference for 1,000-ft-long parallel breakwater extensions (extended due lakeward) at the existing entrance (Severe-Weather Plan 16) for severe-weather conditions. Views of the model ship during operation with Severe-Weather Plans 15 and 16 installed are shown in Photos 158-164.

59. Results of wave-height tests conducted for Severe-Weather Plan 16 for test waves from 279, 326, and 17 deg using the +4.8 ft swl and the 800-cfs Cuyahoga River discharge are presented in Table 33. Evaluation of these data reveals that wave heights in the Lakefront Harbor for Severe-Weather Plan 16, in general, were equal to or less than those obtained for existing conditions. For some wave conditions, wave heights increased slightly at a particular gage location; but overall conditions in the Lakefront Harbor were generally calmer for Severe-Weather Plan 16 than for existing conditions for test waves from all directions. A comparison of wave heights obtained for existing conditions and Severe-Weather Plan 16 is shown in Table 34 for the largest test waves (20- and 100-year recurrence intervals) from each direction. Typical wave patterns obtained for Severe-Weather Plan 16 are shown in Photos 165-170.

Discussion of test results

60. Test results obtained for existing conditions revealed rough and turbulent wave conditions at Cleveland Harbor during period of storm wave attack with wave heights in excess of 26 ft in the arrowhead (west) entrance and 10 ft at the Penn Central Ore Dock. It was determined from navigation tests conducted for existing conditions that the west entrance was not safe and efficient with respect to the passage of 1,000-ft-long vessels even under fair-weather conditions (wave heights up to 4 ft and winds up to 20 knots (23 mph)).

61. Navigation tests conducted for the incremental removal of the east and west spurs (Fair-Weather Plans 1-1C) revealed that, for the safe and efficient passage of 1,000-ft-long vessels at the west entrance during fair-weather conditions, the east and west breakwater spurs should be reduced in length by a minimum of 200 ft and 300 ft,

respectively (Fair-Weather Plan 1A). By removing these spur lengths, the vessel master could begin his turns sooner while entering and leaving the harbor, thus alleviating to some extent the possibility of collision with the piers at the mouth of the Cuyahoga River.

62. The removal of the spur lengths of Fair-Weather Plan 1A resulted in increased wave heights in the Lakefront Harbor. Wave-height tests for various alternatives indicated that wave heights in the Lakefront Harbor could be reduced to where they were, in general, equal to or less than those obtained for existing conditions by installing two 300-ft-long breakwater extensions and raising and sealing the existing west arrowhead breakwater (Fair-Weather Plan 4D). The extensions originated at the lakeward ends of the east and west arrowhead structures and were parallel to the entrance channel. Overall conditions in the Lakefront Harbor were generally calmer for Fair-Weather Plan 4D than for existing conditions for test waves from all directions.

63. The west arrowhead breakwater of Fair-Weather Plan 4D was initially raised to a crest elevation of +18 ft and sealed to prevent the transmission and/or overtopping of the structure. Subsequent wave-height tests revealed that a +10 ft sealed breakwater crest elevation (Fair-Weather Plan 5C) or a +14 ft unsealed breakwater elevation (Fair-Weather Plan 5G) was optimum for this structure.

64. Test results for numerous severe-weather entrance configurations oriented toward the west indicated that wave heights for most plans exceeded the established wave-height criterion (i.e., wave heights in the Lakefront Harbor were greater than those obtained for existing conditions and/or wave heights at the existing entrance (gage 16) were greater than 3 ft). Some plans did meet the established criteria, and it appeared that Severe-Weather Plan 15 was the optimum considering wave heights in the Lakefront Harbor and orientation of the navigation entrance. Navigation tests conducted for Severe-Weather Plan 15, however, indicated some navigational difficulties for severe-weather conditions (wave heights up to 8 ft and winds up to 30 knots (34.5 mph)). Due to the slow entrance speeds and subsequent loss of maneuverability, these wind and wave conditions from 326 and 17 deg tended to set the vessel's stern

toward the shore and its bow lakeward. This situation may be hazardous for the less-skilled and less-experienced vessel masters.

65. After the conduct of navigation tests for numerous alternative entrance configurations for severe-weather conditions, it was determined that 1,000-ft-long breakwater extensions (due lakeward) at the existing entrance (Severe-Weather Plan 16) were optimum with respect to navigation (i.e., preference expressed by vessel masters who participated in model navigation tests). These extensions originated at the lakeward ends of the east and west arrowhead structures and were parallel to the entrance channel. This plan also included the removal of 200 ft and 300 ft, respectively, of the existing east and west breakwater spurs.

66. Wave-height tests for Severe-Weather Plan 16 indicated that wave heights in the Lakefront Harbor were generally equal to or less than those obtained for existing conditions for corresponding wave conditions.

## PART V: CONCLUSIONS

67. Based on the results of the hydraulic model investigation reported herein, it was concluded that:

- a. Existing conditions are characterized by rough and turbulent waves in the west entrance and at various locations in the Lakefront Harbor during periods of storm wave attack.
- b. For existing conditions, the west entrance is not safe and efficient with respect to the navigation of 1,000-ft-long ore carriers even under fair-weather conditions (wave heights up to 4 ft and winds up to 20 knots (23 mph)).
- c. For the safe and efficient passage of 1,000-ft-long vessels at the west entrance during fair-weather conditions, the east and west breakwater spurs should be reduced in length by a minimum of 200 ft and 300 ft, respectively (Fair-Weather Plan 1A).
- d. The removal of the 200- and 300-ft lengths of the east and west breakwater spurs, respectively (Fair-Weather Plan 1A), will increase wave heights in the Lakefront Harbor.
- e. Considering the safe and efficient passage of 1,000-ft-long vessels through the west entrance during fair-weather conditions and wave protection in the Lakefront Harbor (for all wave conditions), Fair-Weather Plan 4D appeared to be optimum.
- f. The optimum crest elevation of the west arrowhead breakwater of Fair-Weather Plan 4D (with respect to wave conditions in the Lakefront Harbor) was determined to be +14 ft (Fair-Weather Plan 5G). This elevation could be lowered to +10 ft provided the structure was sealed (Fair-Weather Plan 5C).
- g. Of the improvement plans tested with the entrance oriented toward the west, Severe-Weather Plan 15 appeared promising considering wave protection in the Lakefront Harbor (for all wave conditions) and orientation of the navigation entrance. Subsequent testing, however, indicated navigational difficulties for severe-weather conditions (wave heights up to 8 ft and winds up to 30 knots (34.5 mph)).
- h. Considering the safe and efficient passage of 1,000-ft-long vessels through the west entrance during severe-weather conditions and wave protection in the Lakefront Harbor (for all wave conditions), Severe-Weather Plan 16 appeared to be optimum.

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Table 1

Wave Heights for All Approach Angles and Seasons

| Recurrence Interval year | Wave Height, ft Angle Class 1 | Wave Height, ft Angle Class 2 | Wave Height, ft Angle Class 3 |
|---|---|---|---|
| | Winter | | |
| 5 | 8.2 | 11.2 | 10.8 |
| 10 | 10.2 | 12.1 | 11.5 |
| 20 | 11.5 | 13.4 | 12.1 |
| 50 | 13.8 | 14.8 | 13.1 |
| 100 | 15.1 | 15.7 | 13.8 |
| | Spring | | |
| 5 | 3.9 | 5.2 | 6.9 |
| 10 | 4.9 | 6.6 | 7.9 |
| 20 | 6.2 | 7.5 | 8.9 |
| 50 | 7.5 | 9.2 | 10.2 |
| 100 | 8.5 | 10.2 | 11.2 |
| | Summer | | |
| 5 | 4.9 | 5.6 | 6.2 |
| 10 | 5.9 | 6.2 | 7.2 |
| 20 | 7.5 | 7.2 | 8.2 |
| 50 | 10.2 | 8.5 | 9.5 |
| 100 | 12.1 | 9.2 | 10.5 |
| | Fall | | |
| 5 | 8.9 | 9.5 | 9.8 |
| 10 | 9.8 | 10.8 | 10.5 |
| 20 | 10.5 | 11.8 | 11.2 |
| 50 | 11.5 | 13.1 | 12.1 |
| 100 | 12.1 | 14.4 | 12.8 |

Table 2

Significant Period, sec, by Angle Class and Wave Height

| Wave Height ft | Significant Period, sec Angle Class 1 | Angle Class 2 | Angle Class 3 |
|---|---|---|---|
| 1 | 2.5 | 2.4 | 2.5 |
| 2 | 3.8 | 3.8 | 3.9 |
| 3 | 4.7 | 4.7 | 4.9 |
| 4 | 5.4 | 5.3 | 5.6 |
| 5 | 6.0 | 5.9 | 6.1 |
| 6 | 6.3 | 6.3 | 6.5 |
| 7 | 6.7 | 6.6 | 6.9 |
| 8 | 7.0 | 6.9 | 7.4 |
| 9 | 7.4 | 7.3 | 7.8 |
| 10 | 7.7 | 7.6 | 8.2 |
| 11 | 8.0 | 8.0 | 8.6 |
| 12 | 8.4 | 8.4 | 9.0 |
| 13 | 8.7 | 8.7 | 9.5 |
| 14 | 9.1 | 9.0 | 9.9 |
| 15 | 9.4 | 9.4 | 10.3 |
| 16 | 9.7 | 9.8 | 10.7 |
| 17 | 10.1 | 10.1 | 11.1 |
| 18 | 10.4 | 10.5 | 11.6 |
| 19 | 10.8 | 10.8 | 12.0 |
| 20 | 11.1 | 11.1 | 12.4 |
| 21 | 11.4 | 11.5 | 12.8 |
| 22 | 11.8 | 11.9 | 13.2 |
| 23 | 12.1 | 12.2 | 13.7 |
| 24 | 12.5 | 12.6 | 14.1 |
| 25 | 12.8 | 12.9 | 14.5 |

Table 3

Wave Heights for Existing Conditions, 0.0-ft swl, River Discharge 800 cfs

| Test Wave | | | Wave Height, ft | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Direction deg | Period sec | Height ft | Gage 1 | Gage 2 | Gage 3 | Gage 4 | Gage 5 | Gage 6 | Gage 7 | Gage 8 | Gage 9 | Gage 10 | Gage 11 | Gage 12 |
| 279 | 6.0 | 3.9 | 0.2 | 0.2 | 0.2 | 0.3 | <0.1 | 0.1 | 0.2 | 0.1 | 0.2 | 0.3 | 0.2 | 0.4 |
| | 7.0 | 5.5 | 0.1 | 0.3 | <0.1 | 0.1 | 0.2 | 0.2 | 0.2 | 0.1 | <0.1 | 0.5 | 0.2 | 0.6 |
| | 8.0 | 6.6 | 0.8 | 0.5 | 0.2 | 0.4 | 0.3 | 0.4 | 0.7 | 0.4 | 0.2 | 0.5 | 0.4 | 0.6 |
| | 9.0 | 4.3 | 0.3 | 0.5 | 0.3 | 0.3 | 0.3 | 0.1 | 0.2 | 0.5 | 0.2 | 0.2 | 0.4 | 0.4 |
| | | 8.1 | 1.1 | 1.3 | 0.8 | 0.6 | 0.7 | 0.4 | 1.1 | 1.1 | 1.1 | 1.1 | 0.9 | 1.6 |
| | | 8.6 | 1.2 | 1.4 | 1.0 | 0.7 | 0.6 | 0.5 | 1.0 | 1.3 | 0.9 | 0.9 | 1.4 | 1.8 |
| | 10.0 | 9.2 | 1.6 | 1.6 | 1.9 | 1.7 | 1.0 | 1.6 | 1.3 | 1.2 | 1.5 | 1.9 | 2.4 | 2.1 |
| 326 | 6.0 | 5.6 | 0.4 | 0.3 | 0.3 | 0.4 | 0.3 | 0.4 | 1.5 | 0.4 | 0.6 | 2.1 | 1.0 | 3.1 |
| | 7.0 | 8.0 | 0.7 | 0.9 | 0.9 | 0.7 | 0.9 | 1.1 | 2.4 | 0.8 | 0.5 | 2.9 | 2.0 | 4.5 |
| | 8.0 | 5.5 | 0.3 | 0.5 | 0.5 | 0.3 | 0.3 | 0.6 | 0.9 | 0.4 | 0.6 | 2.0 | 2.3 | 2.1 |
| | | 10.3 | 2.0 | 1.4 | 1.5 | 1.0 | 1.4 | 2.0 | 3.5 | 1.4 | 1.6 | 4.1 | 4.3 | 4.8 |
| | 8.5 | 10.7 | 1.8 | 2.1 | 2.3 | 1.7 | 2.3 | 2.2 | 3.4 | 1.8 | 2.8 | 3.1 | 4.3 | 5.0 |
| | 9.0 | 6.2 | 0.8 | 0.6 | 0.7 | 0.6 | 0.7 | 1.1 | 1.6 | 0.4 | 1.3 | 1.4 | 2.2 | 2.8 |
| | | 11.9 | 2.4 | 2.3 | 3.3 | 2.5 | 2.8 | 3.2 | 4.2 | 2.5 | 3.9 | 3.2 | 5.7 | 5.7 |
| | 10.0 | 13.7 | 4.3 | 3.2 | 3.4 | 3.9 | 3.7 | 3.5 | 5.0 | 3.0 | 3.4 | 6.7 | 7.3 | 6.4 |
| 17 | 6.0 | 4.7 | 0.4 | 0.2 | 0.4 | 0.2 | 0.2 | 0.7 | 1.1 | 0.2 | 0.4 | 0.8 | 0.4 | 0.9 |
| | 7.0 | 7.3 | 1.0 | 1.0 | 1.0 | 0.6 | 0.7 | 1.2 | 1.8 | 0.7 | 0.8 | 0.8 | 0.5 | 1.8 |
| | 8.0 | 5.1 | 1.2 | 1.0 | 0.8 | 0.5 | 0.7 | 0.6 | 1.7 | 0.4 | 0.6 | 0.7 | 1.0 | 1.0 |
| | | 8.9 | 1.6 | 1.3 | 1.1 | 0.9 | 0.7 | 0.9 | 2.1 | 0.9 | 1.1 | 1.0 | 1.3 | 1.2 |
| | | 9.8 | 1.3 | 1.3 | 1.1 | 0.8 | 0.8 | 1.2 | 1.9 | 0.8 | 1.0 | 1.4 | 1.4 | 2.1 |
| | 9.5 | 12.2 | 2.4 | 2.0 | 1.2 | 1.8 | 1.4 | 1.9 | 3.4 | 1.4 | 1.4 | 2.4 | 3.6 | 4.9 |

(Continued)

Table 3 (Concluded)

| Test Wave | | | Wave Height, ft | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Direction deg | Period sec | Height ft | Gage 13 | Gage 14 | Gage 15 | Gage 16 | Gage 17 | Gage 18 | Gage 19 | Gage 20 | Gage 21 | Gage 22 | Gage 23 | Gage 24 | Gage 25 |
| 279 | 6.0 | 3.9 | 0.8 | 0.6 | 1.1 | 2.5 | 0.7 | 0.5 | 0.7 | <0.1 | 0.4 | <0.1 | <0.1 | 0.2 | 0.3 |
| | 7.0 | 5.5 | 1.0 | 1.4 | 2.4 | 3.8 | 0.6 | 0.4 | 0.4 | 0.2 | 0.1 | <0.1 | 0.5 | <0.1 | 0.4 |
| | 8.0 | 6.6 | 0.7 | 1.0 | 1.5 | 6.1 | 1.2 | 0.6 | 0.5 | 0.6 | 0.1 | 0.8 | 0.3 | 0.3 | 0.5 |
| | 9.0 | 4.3 | 0.5 | 1.4 | 2.3 | 4.0 | 1.1 | 0.9 | 0.8 | 0.6 | 0.6 | 0.7 | 0.3 | 0.4 | 0.3 |
| | | 8.1 | 1.9 | 4.3 | 5.1 | 9.2 | 2.2 | 2.0 | 1.6 | 1.9 | 1.0 | 1.1 | 0.6 | 1.3 | 1.1 |
| | | 8.6 | 2.3 | 4.2 | 5.0 | 10.3 | 3.4 | 1.9 | 1.7 | 2.0 | 1.1 | 1.7 | 0.7 | 0.9 | 1.3 |
| | 10.0 | 9.2 | 3.1 | 5.7 | 6.5 | 11.2 | 3.1 | 2.5 | 1.4 | 2.6 | 1.6 | 1.9 | 0.9 | 2.5 | 1.0 |
| 326 | 6.0 | 5.6 | 3.2 | 4.6 | 5.3 | 2.7 | 2.8 | 1.0 | 1.2 | 0.2 | 0.4 | 0.4 | 0.7 | 0.3 | 0.9 |
| | 7.0 | 8.0 | 5.2 | 6.8 | 7.1 | 9.8 | 5.7 | 1.0 | 1.7 | 0.8 | 1.2 | 0.6 | 1.2 | 0.4 | 1.1 |
| | 8.0 | 5.5 | 3.8 | 4.6 | 5.7 | 2.7 | 3.0 | 1.0 | 1.2 | 0.9 | 0.5 | 0.7 | 0.5 | 0.5 | 0.8 |
| | | 10.3 | 7.1 | 9.8 | 12.7 | 7.6 | 5.8 | 2.8 | 2.5 | 2.2 | 1.3 | 1.6 | 1.5 | 1.2 | 2.2 |
| | 8.5 | 10.7 | 7.9 | 11.0 | 12.4 | 10.2 | 5.9 | 3.7 | 2.3 | 3.3 | 2.1 | 2.2 | 2.2 | 1.6 | 2.3 |
| | 9.0 | 6.2 | 4.0 | 5.3 | 6.2 | 4.1 | 4.2 | 2.1 | 1.1 | 1.7 | 0.8 | 1.1 | 0.8 | 1.0 | 1.1 |
| | | 11.9 | 8.5 | 11.7 | 15.9 | 13.3 | 7.1 | 3.7 | 2.1 | 4.5 | 1.9 | 2.5 | 1.8 | 2.2 | 2.5 |
| | 10.0 | 13.7 | 9.7 | 14.5 | 20.4 | 21.2 | 8.2 | 6.2 | 4.6 | 5.9 | 2.6 | 3.9 | 2.1 | 4.1 | 3.1 |
| 17 | 6.0 | 4.7 | 2.0 | 1.5 | 1.6 | 5.0 | 0.2 | 0.7 | 0.4 | 0.1 | 0.4 | <0.1 | <0.1 | 0.1 | 0.2 |
| | 7.0 | 7.3 | 1.7 | 2.5 | 4.3 | 9.2 | 2.5 | 0.3 | 0.3 | 0.2 | 0.4 | 0.5 | 0.4 | 0.3 | 0.3 |
| | 8.0 | 5.1 | 1.6 | 1.8 | 3.5 | 4.5 | 2.0 | 0.4 | 0.3 | 0.4 | <0.1 | 0.9 | 0.2 | 0.4 | 0.6 |
| | | 8.9 | 2.3 | 2.7 | 4.8 | 7.8 | 1.8 | 0.5 | 0.5 | 0.6 | 0.2 | 0.9 | 0.4 | 0.6 | 0.5 |
| | | 9.8 | 2.7 | 2.9 | 4.6 | 7.0 | 2.2 | 0.8 | 0.7 | 0.8 | 0.2 | 0.9 | 0.4 | 0.6 | 0.6 |
| | 9.5 | 12.2 | 6.2 | 6.4 | 9.7 | 14.4 | 2.8 | 1.4 | 1.1 | 1.5 | 0.8 | 0.9 | 0.4 | 0.6 | 1.1 |

Table 4

Wave Heights for Existing Conditions, 0.0-ft swl, River Discharge 8,000 cfs

| Test Wave | | | Wave Height, ft | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Direction deg | Period sec | Height ft | Gage 1 | Gage 2 | Gage 3 | Gage 4 | Gage 5 | Gage 6 | Gage 7 | Gage 8 | Gage 9 | Gage 10 | Gage 11 | Gage 12 |
| 279 | 6.0 | 3.9 | 0.2 | 0.2 | 0.2 | 0.3 | 0.1 | <0.1 | <0.1 | 0.1 | 0.1 | 0.2 | 0.1 | 0.2 |
| | 7.0 | 5.5 | 0.1 | 0.2 | <0.1 | 0.1 | 0.2 | 0.2 | 0.4 | 0.1 | 0.1 | 0.4 | 0.2 | 0.3 |
| | 8.0 | 6.6 | 0.8 | 0.5 | 0.3 | 0.3 | 0.3 | 0.3 | 0.6 | 0.4 | 0.3 | 0.7 | 0.5 | 0.7 |
| | 9.0 | 4.3 | 0.3 | 0.4 | 0.2 | 0.3 | 0.3 | 0.2 | 0.2 | 0.4 | 0.2 | 0.2 | 0.4 | 0.3 |
| | | 8.1 | 0.9 | 1.3 | 0.9 | 0.5 | 0.6 | 0.5 | 0.8 | 1.1 | 0.9 | 0.7 | 1.0 | 1.4 |
| | | 8.6 | 1.0 | 1.2 | 1.1 | 0.6 | 0.5 | 0.5 | 0.9 | 1.2 | 0.9 | 0.6 | 1.2 | 1.4 |
| | 10.0 | 9.2 | 1.6 | 1.7 | 1.8 | 1.6 | 0.8 | 1.4 | 1.2 | 1.3 | 1.3 | 1.6 | 2.3 | 2.2 |
| 326 | 6.0 | 5.6 | 0.5 | 0.3 | 0.2 | 0.3 | 0.1 | 0.5 | 0.6 | 0.3 | 0.2 | 1.8 | 1.7 | 0.8 |
| | 7.0 | 8.0 | 0.5 | 0.8 | 1.0 | 0.8 | 0.9 | 0.7 | 1.4 | 0.5 | 0.4 | 2.6 | 2.4 | 4.6 |
| | 8.0 | 5.5 | 1.0 | 0.3 | 0.6 | 0.3 | 0.4 | 0.2 | 0.8 | 0.2 | 0.6 | 1.6 | 1.7 | 2.0 |
| | | 10.3 | 1.9 | 1.5 | 1.6 | 1.0 | 1.5 | 2.2 | 3.5 | 1.4 | 1.6 | 5.2 | 5.4 | 5.6 |
| | 8.5 | 10.7 | 2.0 | 1.3 | 1.7 | 1.5 | 1.9 | 2.0 | 3.4 | 1.8 | 2.0 | 3.8 | 5.5 | 5.8 |
| | 9.0 | 6.2 | 0.7 | 0.9 | 0.6 | 0.7 | 0.9 | 0.8 | 1.4 | 0.6 | 1.4 | 1.8 | 2.5 | 3.4 |
| | | 11.9 | 2.8 | 2.7 | 3.2 | 2.5 | 3.1 | 3.6 | 4.4 | 3.5 | 3.9 | 4.2 | 6.9 | 6.5 |
| | 10.0 | 13.7 | 4.0 | 3.6 | 2.8 | 3.8 | 3.3 | 3.6 | 4.9 | 2.5 | 3.4 | 6.8 | 7.7 | 6.6 |
| 17 | 6.0 | 4.7 | 0.5 | 0.3 | 0.3 | 0.2 | 0.2 | 0.7 | 0.9 | 0.3 | 0.4 | 0.4 | 0.3 | 1.1 |
| | 7.0 | 7.3 | 0.8 | 0.6 | 0.9 | 0.5 | 1.0 | 1.2 | 2.0 | 0.5 | 0.9 | 1.3 | 1.0 | 2.5 |
| | 8.0 | 5.1 | 1.0 | 0.9 | 0.7 | 0.3 | 0.7 | 0.8 | 1.3 | 0.3 | 0.5 | 0.9 | 1.2 | 1.4 |
| | | 8.9 | 1.5 | 1.3 | 1.1 | 0.8 | 0.7 | 0.7 | 1.9 | 0.7 | 0.8 | 1.1 | 1.1 | 2.2 |
| | | 9.8 | 1.3 | 1.3 | 1.1 | 1.0 | 1.0 | 1.1 | 2.0 | 0.7 | 0.9 | 1.3 | 1.2 | 2.2 |
| | 9.5 | 12.2 | 2.2 | 1.7 | 1.6 | 1.6 | 1.3 | 1.8 | 3.2 | 1.3 | 1.3 | 2.8 | 3.9 | 6.2 |

(Continued)

Table 4 (Concluded)

| Test Wave | | | Wave Height, ft | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Direction deg | Period sec | Height ft | Gage 13 | Gage 14 | Gage 15 | Gage 16 | Gage 17 | Gage 18 | Gage 19 | Gage 20 | Gage 21 | Gage 22 | Gage 23 | Gage 24 | Gage 25 |
| 279 | 6.0 | 3.9 | 0.7 | 1.0 | 1.3 | 2.4 | 0.8 | 0.4 | 0.5 | <0.1 | 0.5 | <0.1 | <0.1 | <0.1 | 0.2 |
| | 7.0 | 5.5 | 0.8 | 1.3 | 1.9 | 3.6 | 0.8 | 0.2 | 0.3 | 0.1 | 0.1 | 0.1 | 0.3 | 0.1 | 0.4 |
| | 8.0 | 6.6 | 1.0 | 1.2 | 1.6 | 6.4 | 1.4 | 0.5 | 0.5 | 0.6 | 0.2 | 0.8 | 0.3 | 0.3 | 0.6 |
| | 9.0 | 4.3 | 0.5 | 1.0 | 2.1 | 3.7 | 1.1 | 0.9 | 0.7 | 0.5 | 0.6 | 0.7 | 0.2 | 0.4 | 0.3 |
| | | 8.1 | 1.6 | 3.3 | 4.5 | 8.6 | 2.3 | 1.8 | 1.6 | 1.6 | 1.0 | 1.0 | 0.6 | 1.2 | 0.8 |
| | | 8.6 | 2.4 | 4.2 | 5.3 | 10.0 | 3.6 | 1.9 | 1.9 | 1.8 | 0.9 | 1.7 | 0.7 | 1.0 | 1.1 |
| | 10.0 | 9.2 | 3.1 | 5.2 | 6.3 | 12.0 | 2.8 | 2.2 | 1.2 | 2.4 | 1.6 | 1.9 | 1.0 | 2.2 | 1.1 |
| 326 | 6.0 | 5.6 | 1.9 | 3.9 | 3.8 | 2.8 | 3.5 | 0.8 | 1.0 | 0.3 | 0.2 | 0.4 | 0.7 | 0.3 | 0.5 |
| | 7.0 | 8.0 | 5.2 | 7.1 | 7.6 | 8.7 | 6.0 | 1.3 | 1.8 | 0.5 | 1.1 | 1.0 | 1.2 | 0.8 | 1.1 |
| | 8.0 | 5.5 | 2.5 | 4.6 | 3.9 | 4.9 | 3.1 | 1.0 | 1.3 | 1.2 | 0.3 | 0.7 | 0.2 | 0.5 | 1.0 |
| | | 10.3 | 8.6 | 11.2 | 15.0 | 9.4 | 6.1 | 2.8 | 2.4 | 2.0 | 1.4 | 2.0 | 1.5 | 1.2 | 2.4 |
| | 8.5 | 10.7 | 8.6 | 12.1 | 13.0 | 9.2 | 6.2 | 3.8 | 2.3 | 3.0 | 1.8 | 2.3 | 1.5 | 1.9 | 2.3 |
| | 9.0 | 6.2 | 4.3 | 6.0 | 7.2 | 5.3 | 4.6 | 2.2 | 1.2 | 2.2 | 0.9 | 1.4 | 0.7 | 1.5 | 1.4 |
| | | 11.9 | 9.2 | 12.2 | 16.8 | 15.1 | 6.5 | 3.8 | 2.3 | 4.3 | 1.9 | 2.7 | 2.0 | 2.1 | 2.6 |
| | 10.0 | 13.7 | 10.5 | 14.0 | 20.4 | 22.3 | 8.2 | 4.4 | 3.4 | 4.5 | 1.7 | 2.9 | 1.5 | 2.8 | 2.6 |
| 17 | 6.0 | 4.7 | 2.1 | 1.3 | 1.0 | 5.3 | 0.3 | 0.6 | 0.3 | 0.1 | 0.1 | <0.1 | <0.1 | <0.1 | 0.1 |
| | 7.0 | 7.3 | 1.9 | 3.1 | 4.7 | 8.6 | 1.4 | 0.4 | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 | 0.3 |
| | 8.0 | 5.1 | 1.4 | 1.7 | 3.1 | 3.9 | 1.7 | 0.3 | 0.3 | 0.3 | <0.1 | 0.7 | 0.1 | 0.4 | 0.4 |
| | | 8.9 | 2.1 | 2.6 | 4.7 | 7.2 | 1.6 | 0.5 | 0.4 | 0.5 | 0.2 | 0.7 | 0.3 | 0.6 | 0.4 |
| | | 9.8 | 2.6 | 2.2 | 5.0 | 6.9 | 2.2 | 0.7 | 0.7 | 0.8 | 0.3 | 0.8 | 0.4 | 0.7 | 0.4 |
| | 9.5 | 12.2 | 6.3 | 6.1 | 11.0 | 14.9 | 2.5 | 1.2 | 0.8 | 1.2 | 0.5 | 0.8 | 0.3 | 0.6 | 0.8 |

Table 5

Wave Heights for Existing Conditions, +2.6 ft swl, River Discharge 800 cfs

| Test Wave | | | Wave Height, ft | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Direction deg | Period sec | Height ft | Gage 1 | Gage 2 | Gage 3 | Gage 4 | Gage 5 | Gage 6 | Gage 7 | Gage 8 | Gage 9 | Gage 10 | Gage 11 | Gage 12 |
| 279 | 6.0 | 3.9 | 0.5 | 0.2 | 0.3 | 0.3 | 0.2 | <0.1 | 0.3 | <0.1 | 0.1 | 0.1 | <0.1 | 0.2 |
| | 7.0 | 5.5 | 0.4 | 0.4 | 0.4 | 0.4 | 0.5 | 0.2 | 0.5 | 0.5 | 0.4 | 0.4 | 0.2 | 0.6 |
| | 8.0 | 6.6 | 1.2 | 0.9 | 0.8 | 0.7 | 0.8 | 0.5 | 0.9 | 0.8 | 0.7 | 0.5 | 0.9 | 0.8 |
| | 9.0 | 4.3 | 0.4 | 0.6 | 0.8 | 0.8 | 0.4 | 0.2 | 0.4 | 0.7 | 0.5 | 0.4 | 1.2 | 0.6 |
| | | 8.1 | 2.5 | 1.6 | 1.7 | 1.3 | 0.7 | 1.0 | 1.2 | 1.8 | 1.0 | 1.3 | 2.3 | 2.2 |
| | | 8.6 | 3.2 | 2.5 | 2.0 | 1.4 | 1.3 | 1.2 | 1.3 | 2.4 | 1.4 | 1.1 | 1.9 | 1.8 |
| | 10.0 | 9.2 | 2.0 | 2.7 | 3.2 | 2.3 | 1.7 | 2.0 | 1.9 | 2.1 | 2.2 | 1.9 | 2.0 | 2.1 |
| 326 | 6.0 | 5.6 | 0.8 | 0.5 | 0.3 | 0.4 | 0.2 | 0.8 | 1.4 | 0.3 | 0.7 | 1.2 | 1.9 | 3.8 |
| | 7.0 | 8.0 | 0.6 | 0.8 | 0.8 | 1.0 | 1.1 | 1.3 | 2.5 | 0.9 | 0.5 | 2.4 | 2.1 | 4.1 |
| | 8.0 | 5.5 | 0.8 | 0.7 | 0.8 | 0.5 | 0.4 | 0.4 | 0.7 | 0.9 | 0.8 | 2.0 | 2.2 | 2.1 |
| | | 10.3 | 1.7 | 1.8 | 1.6 | 1.4 | 3.2 | 3.6 | 5.0 | 2.7 | 2.6 | 4.3 | 5.3 | 5.7 |
| | 8.5 | 10.7 | 2.5 | 2.0 | 2.5 | 1.9 | 3.3 | 3.5 | 4.7 | 2.4 | 4.0 | 3.3 | 4.7 | 5.5 |
| | 9.0 | 6.2 | 1.6 | 0.9 | 1.9 | 1.3 | 1.5 | 1.7 | 1.2 | 1.6 | 2.0 | 1.6 | 3.8 | 2.7 |
| | | 11.9 | 5.4 | 4.6 | 6.1 | 3.9 | 3.5 | 3.9 | 5.0 | 5.5 | 4.5 | 5.1 | 7.0 | 5.7 |
| | 10.0 | 13.7 | 5.9 | 4.9 | 5.4 | 8.1 | 4.7 | 4.5 | 5.2 | 5.8 | 5.6 | 6.7 | 7.7 | 6.1 |
| 17 | 6.0 | 4.7 | 0.3 | 0.5 | 0.4 | 0.3 | 0.4 | 1.2 | 1.4 | 0.5 | 0.4 | 0.3 | 0.4 | 1.0 |
| | 7.0 | 7.3 | 0.9 | 1.1 | 1.2 | 0.9 | 1.2 | 1.2 | 2.8 | 0.9 | 0.9 | 0.8 | 0.7 | 2.4 |
| | 8.0 | 5.1 | 0.7 | 0.9 | 1.0 | 0.6 | 1.2 | 2.2 | 2.2 | 0.6 | 0.6 | 0.6 | 1.4 | 2.8 |
| | | 8.9 | 1.7 | 1.4 | 1.5 | 1.0 | 1.7 | 3.2 | 3.4 | 0.9 | 1.8 | 1.7 | 3.0 | 4.2 |
| | | 9.8 | 1.8 | 1.1 | 1.4 | 1.0 | 1.6 | 2.8 | 2.9 | 1.1 | 0.9 | 1.7 | 3.0 | 3.6 |
| | 9.5 | 12.2 | 4.2 | 3.8 | 3.0 | 3.2 | 2.1 | 2.5 | 4.2 | 2.1 | 2.5 | 2.6 | 3.5 | 4.5 |

(Continued)

Table 5 (Concluded)

| Test Wave | | | Wave Height, ft | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Direction deg | Period sec | Height ft | Gage 13 | Gage 14 | Gage 15 | Gage 16 | Gage 17 | Gage 18 | Gage 19 | Gage 20 | Gage 21 | Gage 22 | Gage 23 | Gage 24 | Gage 25 |
| 279 | 6.0 | 3.9 | 0.5 | 1.0 | 1.0 | 2.9 | 0.9 | 0.7 | 0.9 | 0.4 | <0.1 | 0.4 | 0.2 | 0.1 | 0.2 |
| | 7.0 | 5.5 | 1.3 | 1.7 | 1.9 | 3.6 | 0.5 | 0.2 | 0.5 | 0.3 | 0.1 | 0.4 | 0.4 | 0.4 | 0.4 |
| | 8.0 | 6.6 | 1.8 | 1.4 | 1.4 | 5.6 | 1.2 | 1.4 | 0.6 | 1.1 | 0.8 | 0.8 | 0.4 | 0.4 | 0.9 |
| | 9.0 | 4.3 | 1.2 | 1.4 | 2.7 | 5.6 | 0.5 | 1.3 | 1.0 | 1.1 | 0.6 | 0.5 | 0.4 | 0.9 | 0.9 |
| | | 8.1 | 3.3 | 3.5 | 4.6 | 7.4 | 1.6 | 1.6 | 1.5 | 1.9 | 1.7 | 1.2 | 1.1 | 1.4 | 1.9 |
| | | 8.6 | 2.3 | 5.5 | 5.6 | 10.5 | 2.0 | 3.4 | 2.3 | 2.5 | 2.0 | 1.4 | 1.4 | 1.2 | 2.3 |
| | 10.0 | 9.2 | 2.9 | 7.8 | 7.1 | 11.9 | 4.6 | 4.0 | 2.6 | 4.2 | 1.5 | 3.2 | 1.2 | 2.4 | 2.4 |
| 326 | 6.0 | 5.6 | 3.2 | 4.6 | 3.9 | 3.3 | 2.0 | 1.4 | 0.3 | 0.3 | 0.3 | 0.8 | 0.4 | 0.6 | 1.3 |
| | 7.0 | 8.0 | 6.1 | 7.2 | 7.8 | 9.2 | 3.2 | 1.1 | 0.5 | 0.7 | 0.5 | 0.7 | 1.3 | 0.3 | 1.6 |
| | 8.0 | 5.5 | 3.3 | 4.9 | 6.4 | 5.0 | 2.8 | 1.1 | 0.6 | 1.1 | 0.9 | 0.7 | 0.5 | 0.6 | 1.1 |
| | | 10.3 | 8.9 | 12.8 | 18.0 | 12.9 | 6.6 | 4.6 | 3.8 | 3.9 | 2.7 | 2.4 | 1.9 | 2.1 | 3.1 |
| | 8.5 | 10.7 | 8.2 | 11.5 | 17.8 | 12.4 | 6.9 | 4.9 | 3.0 | 5.4 | 2.5 | 2.9 | 3.6 | 3.0 | 4.9 |
| | 9.0 | 6.2 | 4.1 | 5.7 | 6.2 | 5.1 | 2.7 | 2.3 | 1.0 | 2.8 | 1.5 | 1.8 | 1.0 | 1.0 | 1.9 |
| | | 11.9 | 9.0 | 13.8 | 21.4 | 20.6 | 8.0 | 6.3 | 3.4 | 4.9 | 2.9 | 3.0 | 3.8 | 4.3 | 4.8 |
| | 10.0 | 13.7 | 9.6 | 12.2 | 21.3 | 23.0 | 9.7 | 6.9 | 5.4 | 6.6 | 3.1 | 4.8 | 2.6 | 4.2 | 4.1 |
| 17 | 6.0 | 4.7 | 1.5 | 2.6 | 2.3 | 6.3 | 1.2 | 0.4 | 0.3 | 0.4 | 0.2 | 0.2 | 0.1 | 0.1 | 0.6 |
| | 7.0 | 7.3 | 3.0 | 3.3 | 5.6 | 9.7 | 1.2 | 0.9 | 0.3 | 0.3 | 0.3 | 0.5 | 0.9 | 0.4 | 0.4 |
| | 8.0 | 5.1 | 2.8 | 2.8 | 4.5 | 5.6 | 1.3 | 0.6 | 0.4 | 0.5 | 0.8 | 0.5 | 0.4 | 0.3 | 0.6 |
| | | 8.9 | 4.3 | 4.3 | 6.4 | 7.9 | 2.6 | 1.3 | 0.5 | 0.7 | 0.8 | 0.9 | 0.8 | 0.8 | 1.1 |
| | | 9.8 | 4.1 | 6.0 | 7.1 | 7.2 | 1.9 | 1.4 | 0.5 | 0.7 | 0.5 | 0.7 | 0.8 | 0.7 | 1.1 |
| | 9.5 | 12.2 | 5.5 | 6.2 | 10.4 | 21.5 | 3.4 | 2.3 | 2.0 | 2.3 | 1.5 | 2.1 | 0.7 | 1.7 | 1.8 |

Table 6

Wave Heights for Existing Conditions, +2.6 ft swl, River Discharge 8,000 cfs

| Test Wave Direction deg | Period sec | Height ft | Wave Height, ft Gage 1 | Gage 2 | Gage 3 | Gage 4 | Gage 5 | Gage 6 | Gage 7 | Gage 8 | Gage 9 | Gage 10 | Gage 11 | Gage 12 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 279 | 6.0 | 3.9 | 0.5 | 0.1 | 0.3 | 0.3 | 0.2 | <0.1 | 0.1 | 0.2 | 0.2 | 0.2 | 0.1 | 0.5 |
| | 7.0 | 5.5 | 0.3 | 0.4 | 0.4 | 0.4 | 0.4 | 0.2 | 0.5 | 0.5 | 0.4 | 0.3 | 0.1 | 0.3 |
| | 8.0 | 6.6 | 1.2 | 0.7 | 0.6 | 0.8 | 0.5 | 0.4 | 0.6 | 0.8 | 0.6 | 0.7 | 0.9 | 1.0 |
| | 9.0 | 4.3 | 0.5 | 0.4 | 1.0 | 0.8 | 0.6 | 0.3 | 0.3 | 0.6 | 0.5 | 0.5 | 1.0 | 0.5 |
| | | 8.1 | 2.0 | 1.8 | 1.7 | 1.6 | 0.8 | 0.9 | 1.2 | 2.2 | 0.9 | 0.7 | 2.1 | 2.0 |
| | | 8.6 | 3.0 | 2.5 | 2.2 | 1.6 | 1.6 | 1.3 | 1.5 | 2.6 | 1.4 | 1.5 | 1.2 | 1.1 |
| | 10.0 | 9.2 | 2.8 | 2.8 | 2.7 | 2.5 | 1.7 | 2.1 | 1.9 | 2.0 | 2.5 | 1.6 | 2.6 | 2.1 |
| 326 | 6.0 | 5.6 | 0.4 | 0.3 | 0.3 | 0.3 | 0.2 | 0.4 | 0.4 | 0.3 | 0.6 | 1.5 | 3.2 | 4.4 |
| | 7.0 | 8.0 | 0.7 | 0.9 | 0.9 | 0.9 | 0.8 | 0.7 | 0.7 | 0.8 | 0.9 | 1.8 | 2.2 | 3.6 |
| | 8.0 | 5.5 | 0.8 | 0.9 | 0.6 | 0.4 | 0.6 | 0.4 | 0.7 | 0.6 | 0.6 | 2.7 | 2.4 | 3.0 |
| | | 10.3 | 2.0 | 2.0 | 1.7 | 1.6 | 3.0 | 3.0 | 4.6 | 2.7 | 2.4 | 6.2 | 7.0 | 6.9 |
| | 8.5 | 10.7 | 2.6 | 2.6 | 2.8 | 2.1 | 3.2 | 4.1 | 4.4 | 2.5 | 4.1 | 4.1 | 6.0 | 6.7 |
| | 9.0 | 6.2 | 1.6 | 1.3 | 2.0 | 1.1 | 1.2 | 1.6 | 1.3 | 0.7 | 1.5 | 2.4 | 4.1 | 3.4 |
| | | 11.9 | 6.2 | 4.9 | 5.6 | 3.3 | 3.7 | 4.3 | 4.7 | 4.9 | 4.6 | 6.4 | 7.8 | 6.0 |
| | 10.0 | 13.7 | 6.3 | 5.7 | 5.6 | 6.6 | 4.6 | 4.5 | 6.3 | 6.5 | 5.6 | 7.9 | 8.7 | 6.7 |
| 17 | 5.6 | 4.7 | <0.1 | 0.3 | 0.2 | 0.3 | 0.2 | 1.1 | 1.1 | 0.2 | 0.3 | 0.2 | <0.1 | 0.9 |
| | 7.0 | 7.3 | 0.6 | 1.2 | 1.0 | 0.9 | 1.1 | 0.9 | 2.8 | 0.6 | 0.5 | 0.6 | 0.8 | 2.1 |
| | 8.0 | 5.1 | 0.8 | 0.7 | 0.8 | 0.6 | 0.9 | 1.8 | 2.5 | 0.8 | 0.7 | 0.5 | 1.5 | 2.5 |
| | | 8.9 | 1.5 | 1.4 | 1.4 | 1.1 | 1.6 | 2.8 | 3.3 | 1.1 | 1.6 | 1.7 | 2.4 | 3.7 |
| | | 9.8 | 1.8 | 1.7 | 1.6 | 0.9 | 1.5 | 2.1 | 3.0 | 1.5 | 1.6 | 2.0 | 1.8 | 3.4 |
| | 9.5 | 12.2 | 4.4 | 4.9 | 3.7 | 3.3 | 3.1 | 2.8 | 4.6 | 2.8 | 2.2 | 2.7 | 2.9 | 4.5 |

(Continued)

Table 6 (Concluded)

| Test Wave | | | Wave Height, ft | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Direction deg | Period sec | Height ft | Gage 13 | Gage 14 | Gage 15 | Gage 16 | Gage 17 | Gage 18 | Gage 19 | Gage 20 | Gage 21 | Gage 22 | Gage 23 | Gage 24 | Gage 25 |
| 279 | 6.0 | 3.9 | 0.2 | 1.2 | 1.2 | 2.7 | 0.8 | 0.9 | 1.0 | 0.5 | <0.1 | 0.4 | 0.2 | 0.1 | 0.2 |
| | 7.0 | 5.5 | 1.1 | 1.3 | 1.6 | 3.7 | 0.5 | 0.2 | 0.5 | 0.2 | 0.2 | 0.4 | 0.4 | 0.3 | 0.5 |
| | 8.0 | 6.6 | 1.9 | 1.3 | 1.2 | 3.5 | 1.1 | 0.8 | 0.4 | 0.7 | 0.5 | 0.5 | 0.5 | 0.4 | 0.6 |
| | 9.0 | 4.3 | 1.3 | 1.4 | 2.8 | 5.5 | 0.7 | 1.4 | 0.9 | 1.0 | 0.5 | 0.6 | 0.4 | 0.8 | 0.8 |
| | | 8.1 | 2.8 | 4.2 | 4.4 | 8.3 | 1.7 | 1.7 | 1.5 | 2.1 | 1.5 | 0.8 | 1.3 | 1.0 | 1.7 |
| | | 8.6 | 1.5 | 5.0 | 6.3 | 10.9 | 1.8 | 3.4 | 2.2 | 2.0 | 1.8 | 1.6 | 1.2 | 1.3 | 2.4 |
| | 10.0 | 9.2 | 2.5 | 5.8 | 6.9 | 11.5 | 3.0 | 4.2 | 2.3 | 4.3 | 1.1 | 3.3 | 1.3 | 3.1 | 2.2 |
| 326 | 6.0 | 5.6 | 3.5 | 4.4 | 3.7 | 3.3 | 2.6 | 1.0 | 0.3 | 0.9 | 0.3 | 0.3 | 0.2 | 0.3 | 1.0 |
| | 7.0 | 8.0 | 4.6 | 6.2 | 6.8 | 8.8 | 4.3 | 1.3 | 0.7 | 0.8 | 0.7 | 0.6 | 1.2 | 0.8 | 1.9 |
| | 8.0 | 5.5 | 3.8 | 5.6 | 7.2 | 4.6 | 3.4 | 1.1 | 0.8 | 1.0 | 1.1 | 0.4 | 0.5 | 0.8 | 1.2 |
| | | 10.3 | 10.6 | 13.8 | 18.6 | 14.1 | 6.7 | 4.9 | 3.7 | 4.1 | 3.2 | 2.8 | 2.2 | 2.4 | 3.5 |
| | 8.5 | 10.7 | 8.6 | 12.7 | 20.6 | 13.6 | 7.2 | 6.0 | 3.3 | 5.2 | 2.5 | 3.6 | 4.1 | 3.3 | 4.6 |
| | 9.0 | 6.2 | 5.0 | 6.4 | 7.4 | 6.4 | 3.1 | 3.1 | 1.5 | 3.3 | 1.8 | 1.8 | 0.9 | 0.9 | 2.3 |
| | | 11.9 | 9.5 | 14.1 | 20.7 | 22.1 | 7.6 | 6.3 | 3.7 | 5.2 | 2.0 | 3.3 | 2.9 | 4.5 | 4.1 |
| | 10.0 | 13.7 | 9.9 | 13.1 | 19.1 | 25.0 | 9.7 | 7.1 | 5.6 | 6.7 | 3.2 | 4.9 | 2.7 | 4.4 | 4.4 |
| 17 | 5.6 | 4.7 | 0.7 | 2.1 | 1.8 | 5.5 | 0.6 | 0.1 | <0.1 | 0.2 | <0.1 | <0.1 | 0.1 | <0.1 | 0.5 |
| | 7.0 | 7.3 | 2.9 | 3.0 | 4.8 | 10.6 | 1.2 | 0.8 | 0.3 | 0.3 | 0.2 | 0.3 | 0.6 | 0.3 | 0.5 |
| | 8.0 | 5.1 | 2.6 | 2.6 | 4.1 | 5.0 | 0.8 | 0.7 | 0.3 | 0.4 | 0.6 | 0.5 | 0.4 | 0.4 | 0.6 |
| | | 8.9 | 4.1 | 5.0 | 5.3 | 7.3 | 2.4 | 1.4 | 0.5 | 0.7 | 0.6 | 0.8 | 0.9 | 0.7 | 1.1 |
| | | 9.8 | 4.0 | 5.6 | 6.3 | 8.1 | 1.5 | 1.4 | 1.0 | 1.1 | 0.4 | 1.1 | 0.8 | 0.8 | 1.1 |
| | 9.5 | 12.2 | 5.3 | 7.0 | 9.2 | 22.8 | 3.2 | 2.0 | 1.8 | 2.1 | 1.3 | 1.8 | 0.6 | 1.7 | 1.7 |

Table 7

Wave Heights for Existing Conditions, +4.8 ft swl, River Discharge 800 cfs

| Test Wave Direction deg | Period sec | Height ft | Wave Height, ft Gage 1 | Gage 2 | Gage 3 | Gage 4 | Gage 5 | Gage 6 | Gage 7 | Gage 8 | Gage 9 | Gage 10 | Gage 11 | Gage 12 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 279 | 6.0 | 3.9 | 0.2 | 0.1 | 0.3 | 0.5 | 0.2 | 0.1 | 0.3 | 0.3 | <0.1 | 0.1 | 0.3 | 0.3 |
| | 7.0 | 5.5 | 0.4 | 0.4 | 0.4 | 0.3 | 0.4 | 0.2 | 0.4 | 0.5 | 0.2 | 0.4 | 0.3 | 0.5 |
| | 8.0 | 6.6 | 0.8 | 1.4 | 1.0 | 0.6 | 0.6 | 0.6 | 0.8 | 1.1 | 0.6 | 0.6 | 1.3 | 1.0 |
| | 9.0 | 4.3 | 0.8 | 0.7 | 1.8 | 0.8 | 0.4 | 0.3 | 0.8 | 0.4 | 0.7 | 0.6 | 0.7 | 0.9 |
| | | 8.6 | 4.4 | 2.1 | 3.6 | 2.5 | 1.8 | 1.7 | 2.4 | 1.8 | 2.2 | 1.7 | 2.1 | 2.6 |
| | 10.0 | 9.2 | 3.3 | 3.0 | 3.5 | 3.0 | 3.3 | 3.9 | 3.6 | 2.7 | 3.0 | 1.3 | 2.6 | 2.9 |
| 326 | 6.0 | 5.6 | 0.9 | 0.4 | 0.3 | 0.5 | 0.6 | 0.5 | 1.5 | 0.5 | 0.7 | 3.2 | 2.7 | 4.6 |
| | 7.0 | 8.0 | 1.1 | 2.3 | 1.8 | 1.7 | 1.3 | 1.7 | 3.1 | 1.9 | 2.0 | 3.6 | 3.4 | 4.8 |
| | 8.0 | 5.5 | 0.7 | 1.1 | 0.6 | 0.5 | 1.0 | 1.0 | 1.3 | 0.8 | 0.8 | 1.6 | 2.0 | 2.3 |
| | | 10.3 | 2.5 | 4.0 | 4.1 | 3.4 | 3.2 | 3.4 | 3.5 | 4.4 | 4.2 | 3.2 | 4.7 | 5.1 |
| | 9.0 | 6.2 | 3.6 | 1.9 | 2.1 | 1.4 | 1.6 | 1.5 | 2.1 | 2.0 | 1.8 | 2.3 | 2.6 | 3.4 |
| | | 11.9 | 5.1 | 5.6 | 7.3 | 5.3 | 6.0 | 5.1 | 5.2 | 7.1 | 5.6 | 5.8 | 7.4 | 8.2 |
| | 10.0 | 13.7 | 5.8 | 6.8 | 9.1 | 9.4 | 5.8 | 6.1 | 7.3 | 7.6 | 7.0 | 7.3 | 8.9 | 8.1 |
| 17 | 6.0 | 4.7 | 0.8 | 0.8 | 0.5 | 0.1 | 0.9 | 1.5 | 2.1 | 0.3 | 1.0 | 0.1 | 0.7 | 0.9 |
| | 7.0 | 7.3 | 1.3 | 2.0 | 0.6 | 0.9 | 0.7 | 1.7 | 2.9 | 1.5 | 1.8 | 1.8 | 1.7 | 3.4 |
| | 8.0 | 5.1 | 1.9 | 1.8 | 1.4 | 0.5 | 1.9 | 1.6 | 2.2 | 1.6 | 1.2 | 1.4 | 1.1 | 2.4 |
| | | 9.8 | 1.2 | 1.9 | 2.2 | 1.5 | 1.9 | 2.4 | 3.0 | 1.8 | 1.8 | 1.3 | 3.8 | 3.4 |
| | 9.5 | 12.2 | 5.6 | 6.7 | 6.7 | 7.0 | 4.4 | 4.2 | 6.0 | 7.1 | 4.2 | 3.5 | 4.8 | 6.5 |

(Continued)

Table 7 (Concluded)

| Test Wave | | | Wave Height, ft | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Direction deg | Period sec | Height ft | Gage 13 | Gage 14 | Gage 15 | Gage 16 | Gage 17 | Gage 18 | Gage 19 | Gage 20 | Gage 21 | Gage 22 | Gage 23 | Gage 24 | Gage 25 |
| 279 | 6.0 | 3.9 | 0.5 | 1.5 | 0.6 | 1.4 | 0.9 | 0.3 | 0.6 | 0.5 | 0.3 | 0.3 | 0.4 | 0.2 | 0.2 |
| | 7.0 | 5.5 | 1.3 | 2.5 | 3.0 | 2.6 | 2.1 | 1.1 | 0.7 | 0.3 | 0.3 | 0.8 | 0.4 | 0.4 | 0.8 |
| | 8.0 | 6.6 | 1.6 | 2.8 | 3.0 | 5.3 | 2.8 | 2.3 | 1.3 | 1.6 | 0.6 | 1.6 | 1.2 | 1.4 | 1.5 |
| | 9.0 | 4.3 | 1.1 | 1.0 | 2.1 | 5.1 | 1.7 | 1.3 | 0.4 | 0.9 | 0.7 | 0.8 | 0.5 | 0.6 | 0.8 |
| | | 8.6 | 3.7 | 4.7 | 6.4 | 13.1 | 2.0 | 4.7 | 2.9 | 5.7 | 3.1 | 4.4 | 2.1 | 1.8 | 3.0 |
| | 10.0 | 9.2 | 3.3 | 8.1 | 7.7 | 13.4 | 2.8 | 5.7 | 4.1 | 6.1 | 4.3 | 6.1 | 2.8 | 4.7 | 3.1 |
| 326 | 6.0 | 5.6 | 5.3 | 6.0 | 5.0 | 4.6 | 2.1 | 1.8 | 0.4 | 0.9 | 1.8 | 0.7 | 1.1 | 1.0 | 0.8 |
| | 7.0 | 8.0 | 5.7 | 7.6 | 8.1 | 9.6 | 5.0 | 1.9 | 1.5 | 1.2 | 1.4 | 1.3 | 3.0 | 1.2 | 1.7 |
| | 8.0 | 5.5 | 3.8 | 4.8 | 5.5 | 3.0 | 3.7 | 1.1 | 0.9 | 1.9 | 0.9 | 1.3 | 0.3 | 0.6 | 1.6 |
| | | 10.3 | 8.3 | 11.9 | 15.9 | 12.3 | 8.2 | 5.1 | 3.4 | 4.9 | 2.5 | 4.0 | 2.1 | 3.7 | 5.8 |
| | 9.0 | 6.2 | 4.4 | 6.2 | 6.7 | 5.1 | 4.8 | 2.7 | 2.3 | 3.0 | 2.2 | 1.7 | 2.9 | 1.6 | 3.6 |
| | | 11.9 | 10.1 | 12.3 | 18.7 | 17.4 | 8.8 | 6.6 | 5.3 | 5.7 | 4.5 | 5.3 | 5.4 | 5.5 | 6.3 |
| | 10.0 | 13.7 | 11.7 | 14.4 | 18.3 | 26.2 | 8.5 | 9.1 | 5.4 | 7.0 | 5.5 | 6.0 | 5.8 | 6.0 | 5.5 |
| 17 | 6.0 | 4.7 | 0.9 | 2.8 | 4.2 | 3.9 | 1.3 | 0.8 | 0.4 | 0.6 | 0.8 | 0.5 | 0.1 | 0.3 | 0.5 |
| | 7.0 | 7.3 | 3.2 | 4.8 | 6.9 | 9.3 | 1.0 | 1.5 | 0.6 | 1.2 | 0.5 | 0.6 | 1.1 | 0.6 | 1.6 |
| | 8.0 | 5.1 | 2.8 | 2.7 | 4.2 | 4.3 | 0.7 | 1.3 | 0.9 | 1.0 | 0.7 | 0.7 | 0.5 | 0.4 | 1.4 |
| | | 9.8 | 4.8 | 5.8 | 7.4 | 10.6 | 3.1 | 2.5 | 1.7 | 1.6 | 1.8 | 1.4 | 1.0 | 1.2 | 2.5 |
| | 9.5 | 12.2 | 6.8 | 9.8 | 11.9 | 24.0 | 4.4 | 3.3 | 2.4 | 3.8 | 2.4 | 3.1 | 1.7 | 3.9 | 3.4 |

Table 8

Wave Heights for Existing Conditions, +4.8 ft swl, River Discharge 8,000 cfs

| Test Wave | | | Wave Height, ft | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Direction deg | Period sec | Height ft | Gage 1 | Gage 2 | Gage 3 | Gage 4 | Gage 5 | Gage 6 | Gage 7 | Gage 8 | Gage 9 | Gage 10 | Gage 11 | Gage 12 |
| 279 | 6.0 | 3.9 | 0.3 | <0.1 | 0.3 | 0.4 | 0.1 | 0.2 | 0.2 | 0.3 | <0.1 | 0.4 | <0.1 | 0.4 |
| | 7.0 | 5.5 | 0.5 | 0.5 | 0.5 | 0.4 | 0.5 | 0.4 | 0.4 | 0.3 | 0.3 | 0.4 | 0.3 | 0.6 |
| | 8.0 | 6.6 | 0.7 | 1.6 | 1.1 | 0.5 | 0.5 | 0.5 | 0.8 | 0.7 | 0.7 | 0.6 | 1.1 | 1.1 |
| | 9.0 | 4.3 | 0.7 | 0.7 | 1.7 | 0.7 | 0.4 | 0.2 | 0.9 | 0.3 | 0.7 | 0.5 | 0.8 | 0.7 |
| | | 8.6 | 4.7 | 2.3 | 4.0 | 2.4 | 2.1 | 1.7 | 2.4 | 2.3 | 2.0 | 1.7 | 2.2 | 1.9 |
| | 10.0 | 9.2 | 3.5 | 2.6 | 3.5 | 3.7 | 3.6 | 3.9 | 3.5 | 2.8 | 2.9 | 1.5 | 2.7 | 3.0 |
| 326 | 6.0 | 5.6 | 0.6 | 0.6 | 0.2 | 0.7 | 0.4 | 0.6 | 0.5 | 0.7 | 0.7 | 1.9 | 2.9 | 4.0 |
| | 7.0 | 8.0 | 1.1 | 2.1 | 1.7 | 1.7 | 1.7 | 1.3 | 2.2 | 1.5 | 1.5 | 3.9 | 3.4 | 5.3 |
| | 8.0 | 5.5 | 0.7 | 1.1 | 0.4 | 0.4 | 0.8 | 0.7 | 1.4 | 0.9 | 0.7 | 2.4 | 2.5 | 3.5 |
| | | 10.3 | 3.0 | 3.1 | 4.8 | 2.7 | 3.7 | 3.4 | 2.9 | 4.1 | 3.8 | 3.9 | 5.2 | 6.0 |
| | 9.0 | 6.2 | 3.3 | 1.8 | 2.1 | 1.3 | 1.3 | 1.2 | 1.8 | 1.9 | 2.2 | 2.2 | 3.1 | 3.6 |
| | | 11.9 | 4.6 | 5.7 | 7.8 | 6.5 | 5.7 | 4.2 | 4.6 | 7.8 | 5.7 | 6.9 | 6.9 | 6.9 |
| | 10.0 | 13.7 | 5.3 | 6.0 | 7.3 | 8.0 | 6.2 | 6.3 | 6.6 | 7.2 | 6.4 | 7.9 | 8.9 | 8.0 |
| 17 | 6.0 | 4.7 | 0.7 | 0.6 | 0.4 | 0.2 | 0.7 | 1.4 | 1.8 | 0.3 | 1.1 | 0.5 | 0.4 | 0.7 |
| | 7.0 | 7.3 | 1.3 | 1.8 | 0.9 | 0.9 | 0.6 | 1.9 | 2.8 | 1.5 | 0.9 | 1.3 | 1.1 | 2.0 |
| | 8.0 | 5.1 | 1.9 | 1.7 | 1.3 | 0.8 | 2.1 | 1.8 | 2.4 | 1.2 | 1.1 | 1.6 | 0.9 | 2.1 |
| | | 9.8 | 1.4 | 2.0 | 1.9 | 1.5 | 2.1 | 2.7 | 2.2 | 2.1 | 2.1 | 1.1 | 2.9 | 2.0 |
| | 9.5 | 12.2 | 7.2 | 7.0 | 10.9 | 6.7 | 6.2 | 4.8 | 6.2 | 7.1 | 4.1 | 3.7 | 4.3 | 6.4 |

(Continued)

Table 8 (Concluded)

| Test Wave | | | Wave Height, ft | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Direction deg | Period sec | Height ft | Gage 13 | Gage 14 | Gage 15 | Gage 16 | Gage 17 | Gage 18 | Gage 19 | Gage 20 | Gage 21 | Gage 22 | Gage 23 | Gage 24 | Gage 25 |
| 279 | 6.0 | 3.9 | 0.2 | 1.6 | 1.0 | 1.2 | 0.5 | 0.4 | 0.8 | 0.5 | 0.6 | 0.4 | 0.4 | 0.2 | 0.3 |
| | 7.0 | 5.5 | 1.5 | 1.8 | 2.6 | 2.4 | 1.8 | 1.0 | 0.7 | 0.4 | 0.3 | 0.9 | 0.8 | 0.6 | 0.7 |
| | 8.0 | 6.6 | 1.6 | 2.7 | 2.2 | 4.4 | 1.5 | 1.7 | 0.9 | 1.9 | 0.5 | 0.8 | 1.1 | 1.4 | 1.1 |
| | 9.0 | 4.3 | 0.8 | 1.3 | 1.8 | 5.2 | 1.6 | 0.9 | 0.5 | 0.6 | 0.6 | 0.6 | 0.3 | 0.7 | 0.7 |
| | | 8.6 | 3.9 | 4.8 | 4.7 | 13.3 | 1.7 | 4.4 | 2.7 | 5.2 | 3.9 | 5.0 | 2.1 | 2.2 | 2.8 |
| | 10.0 | 9.2 | 3.5 | 6.2 | 5.9 | 12.0 | 2.9 | 5.3 | 3.7 | 4.9 | 3.4 | 6.8 | 2.6 | 6.0 | 3.6 |
| 326 | 6.0 | 5.6 | 4.3 | 5.6 | 3.5 | 4.8 | 2.1 | 0.8 | 0.3 | 1.2 | 1.5 | 0.8 | 0.8 | 0.8 | 0.9 |
| | 7.0 | 8.0 | 6.1 | 7.8 | 9.1 | 9.0 | 5.0 | 2.0 | 2.2 | 1.3 | 1.4 | 1.9 | 1.7 | 1.2 | 2.7 |
| | 8.0 | 5.5 | 4.7 | 5.7 | 7.1 | 4.9 | 4.4 | 1.3 | 1.1 | 1.5 | 0.9 | 1.3 | 0.5 | 0.9 | 2.0 |
| | | 10.3 | 8.9 | 12.0 | 17.2 | 11.2 | 7.8 | 4.4 | 3.2 | 4.6 | 2.2 | 4.2 | 2.3 | 2.5 | 6.3 |
| | 9.0 | 6.2 | 4.6 | 6.3 | 7.4 | 5.9 | 4.2 | 2.4 | 1.6 | 3.4 | 2.1 | 1.4 | 2.8 | 1.1 | 3.7 |
| | | 11.9 | 10.1 | 12.9 | 18.5 | 24.7 | 8.7 | 7.0 | 5.8 | 7.1 | 4.6 | 5.8 | 5.5 | 3.6 | 6.3 |
| | 10.0 | 13.7 | 10.4 | 14.6 | 18.5 | 24.0 | 9.6 | 9.0 | 4.8 | 7.4 | 6.3 | 7.1 | 5.7 | 5.9 | 6.3 |
| 17 | 6.0 | 4.7 | 0.7 | 1.8 | 2.6 | 4.0 | 1.5 | 0.3 | 0.2 | 0.4 | 0.8 | 0.5 | 0.2 | 0.3 | 0.6 |
| | 7.0 | 7.3 | 2.7 | 4.4 | 6.2 | 9.9 | 0.8 | 1.9 | 0.7 | 1.0 | 0.4 | 1.0 | 1.1 | 0.9 | 1.2 |
| | 8.0 | 5.1 | 2.6 | 2.4 | 3.7 | 5.2 | 1.0 | 1.4 | 0.9 | 0.6 | 0.7 | 1.0 | 0.5 | 0.5 | 1.6 |
| | | 9.8 | 3.9 | 6.0 | 6.5 | 9.3 | 2.2 | 2.4 | 1.7 | 1.7 | 1.7 | 1.4 | 1.0 | 1.1 | 2.6 |
| | 9.5 | 12.2 | 5.8 | 10.0 | 12.5 | 25.0 | 3.1 | 3.9 | 3.0 | 3.4 | 1.9 | 2.7 | 1.7 | 3.8 | 3.9 |

Table 9

Wave Heights for Fair-Weather Plans 1-1C for Waves from 326 deg, +2.6 ft swl, River Discharge 800 cfs

| | Test Wave | | Wave Height, ft | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Plan | Period sec | Height ft | Gage 1 | Gage 2 | Gage 3 | Gage 4 | Gage 5 | Gage 6 | Gage 7 | Gage 8 |
| 1 | 6.0 | 5.6 | 0.5 | 0.3 | 0.3 | 0.3 | 0.3 | 0.5 | 1.9 | 0.5 |
| | 7.0 | 8.0 | 1.5 | 1.9 | 1.0 | 1.0 | 1.1 | 1.1 | 2.2 | 0.7 |
| | 8.0 | 5.5 | 0.8 | 0.7 | 0.6 | 0.5 | 0.5 | 0.3 | 2.2 | 0.4 |
| | | 10.3 | 2.9 | 2.2 | 2.0 | 1.5 | 2.7 | 3.2 | 5.3 | 2.7 |
| | 8.5 | 10.7 | 3.1 | 2.2 | 2.6 | 2.4 | 3.5 | 3.8 | 5.7 | 3.3 |
| | 9.0 | 6.2 | 1.1 | 1.3 | 1.7 | 1.3 | 1.0 | 1.2 | 1.3 | 1.3 |
| | | 11.9 | 4.7 | 3.5 | 5.1 | 4.4 | 3.8 | 4.2 | 5.9 | 3.5 |
| | 10.0 | 13.7 | 6.3 | 6.1 | 4.6 | 5.8 | 4.5 | 4.6 | 5.8 | 4.5 |
| 1A | 6.0 | 5.6 | 0.4 | 0.4 | 0.2 | 0.6 | 0.4 | 0.7 | 2.0 | 0.5 |
| | 7.0 | 8.0 | 1.5 | 1.4 | 1.3 | 1.1 | 1.0 | 1.0 | 3.0 | 1.0 |
| | 8.0 | 5.5 | 0.9 | 0.4 | 0.4 | 0.2 | 0.8 | 0.5 | 1.3 | 0.4 |
| | | 10.3 | 2.1 | 2.3 | 2.1 | 2.3 | 2.0 | 1.9 | 4.9 | 2.7 |
| | 8.5 | 10.7 | 3.5 | 3.4 | 1.9 | 2.6 | 4.6 | 3.9 | 6.0 | 2.9 |
| | 9.0 | 6.2 | 1.6 | 2.0 | 2.3 | 1.8 | 1.5 | 1.6 | 2.2 | 1.2 |
| | | 11.9 | 5.1 | 6.1 | 5.2 | 4.2 | 5.5 | 4.8 | 6.2 | 4.9 |
| | 10.0 | 13.7 | 6.5 | 6.7 | 7.0 | 5.9 | 5.7 | 5.5 | 7.1 | 6.3 |
| 1B | 6.0 | 5.6 | 0.4 | 0.6 | 0.5 | 0.6 | 0.6 | 0.6 | 1.7 | 0.5 |
| | 7.0 | 8.0 | 0.8 | 0.8 | 0.8 | 1.4 | 1.0 | 0.6 | 2.6 | 1.0 |
| | 8.0 | 5.5 | 0.9 | 0.6 | 0.4 | 0.4 | 0.8 | 0.6 | 1.6 | 0.9 |
| | | 10.3 | 2.0 | 1.9 | 1.6 | 1.5 | 3.1 | 2.1 | 5.8 | 2.1 |
| | 8.5 | 10.7 | 2.1 | 1.7 | 2.1 | 1.8 | 2.2 | 2.8 | 5.4 | 2.7 |
| | 9.0 | 6.2 | 1.5 | 1.4 | 1.4 | 0.9 | 0.4 | 1.4 | 0.9 | 1.6 |
| | | 11.9 | 3.8 | 3.8 | 3.7 | 2.6 | 4.5 | 5.6 | 7.5 | 3.9 |
| | 10.0 | 13.7 | 4.9 | 5.6 | 5.0 | 4.3 | 4.6 | 5.6 | 7.0 | 4.4 |
| 1C | 6.0 | 5.6 | 0.5 | 0.3 | 0.4 | 0.4 | 0.4 | 0.8 | 1.9 | 0.3 |
| | 7.0 | 8.0 | 0.9 | 1.3 | 1.0 | 1.2 | 0.7 | 0.7 | 4.6 | 1.1 |
| | 8.0 | 5.5 | 0.9 | 0.9 | 0.2 | 0.3 | 0.9 | 0.5 | 1.0 | 0.7 |
| | | 10.3 | 1.4 | 1.9 | 1.7 | 1.3 | 3.5 | 2.7 | 6.0 | 2.3 |
| | 8.5 | 10.7 | 2.9 | 2.6 | 3.0 | 2.5 | 3.7 | 4.2 | 6.0 | 2.9 |
| | 9.0 | 6.2 | 2.0 | 1.5 | 2.1 | 1.2 | 1.5 | 1.6 | 3.3 | 1.2 |
| | | 11.9 | 4.2 | 4.4 | 5.6 | 3.8 | 3.9 | 4.3 | 6.2 | 5.0 |
| | 10.0 | 13.7 | 3.8 | 6.1 | 6.8 | 5.8 | 5.7 | 5.8 | 6.8 | 6.2 |

(Continued)

Table 9 (Continued)

| Test Wave | | | Wave Height, ft | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Plan | Period sec | Height ft | Gage 9 | Gage 10 | Gage 11 | Gage 12 | Gage 13 | Gage 14 | Gage 15 | Gage 16 |
| 1 | 6.0 | 5.6 | 0.4 | 2.1 | 3.0 | 3.9 | 3.8 | 5.7 | 4.6 | 3.7 |
| | 7.0 | 8.0 | 1.3 | 2.6 | 2.9 | 4.6 | 6.4 | 8.1 | 7.9 | 12.0 |
| | 8.0 | 5.5 | 0.9 | 1.1 | 2.4 | 2.8 | 3.5 | 3.9 | 5.4 | 4.3 |
| | | 10.3 | 3.5 | 3.6 | 5.1 | 6.7 | 9.5 | 11.4 | 16.4 | 16.4 |
| | 8.5 | 10.7 | 3.7 | 3.6 | 5.8 | 6.5 | 8.9 | 13.1 | 21.5 | 17.9 |
| | 9.0 | 6.2 | 1.5 | 2.1 | 3.8 | 2.8 | 3.8 | 6.1 | 7.8 | 8.8 |
| | | 11.9 | 3.9 | 4.6 | 6.1 | 6.3 | 9.4 | 12.7 | 20.1 | 18.8 |
| | 10.0 | 13.7 | 4.3 | 6.8 | 7.3 | 6.3 | 9.4 | 12.3 | 20.0 | 24.1 |
| 1A | 6.0 | 5.6 | 0.5 | 2.4 | 1.9 | 3.7 | 3.7 | 4.7 | 5.0 | 3.4 |
| | 7.0 | 8.0 | 1.5 | 2.2 | 2.0 | 4.0 | 4.3 | 7.9 | 6.4 | 11.2 |
| | 8.0 | 5.5 | 0.8 | 1.8 | 1.8 | 2.4 | 2.8 | 5.9 | 6.3 | 1.8 |
| | | 10.3 | 2.1 | 3.0 | 4.6 | 4.6 | 7.2 | 10.6 | 13.9 | 10.3 |
| | 8.5 | 10.7 | 3.8 | 3.0 | 4.6 | 5.1 | 9.1 | 13.0 | 19.9 | 12.2 |
| | 9.0 | 6.2 | 2.1 | 2.7 | 4.2 | 3.6 | 4.7 | 8.0 | 10.3 | 9.6 |
| | | 11.9 | 5.1 | 5.0 | 6.7 | 7.5 | 10.3 | 14.9 | 23.2 | 24.6 |
| | 10.0 | 13.7 | 5.1 | 8.8 | 8.9 | 7.8 | 11.2 | 18.6 | 22.7 | 25.9 |
| 1B | 6.0 | 5.6 | 0.6 | 2.0 | 2.0 | 3.7 | 3.0 | 4.2 | 4.3 | 4.0 |
| | 7.0 | 8.0 | 0.6 | 2.2 | 2.1 | 4.0 | 5.1 | 7.0 | 7.8 | 11.3 |
| | 8.0 | 5.5 | 0.8 | 1.4 | 2.0 | 2.4 | 3.1 | 5.1 | 4.1 | 2.7 |
| | | 10.3 | 2.0 | 3.6 | 4.5 | 5.4 | 7.5 | 12.7 | 18.4 | 12.0 |
| | 8.5 | 10.7 | 3.1 | 2.9 | 4.6 | 5.0 | 7.2 | 11.5 | 16.7 | 12.6 |
| | 9.0 | 6.2 | 1.1 | 1.7 | 3.1 | 2.5 | 4.0 | 6.1 | 8.7 | 7.4 |
| | | 11.9 | 4.1 | 4.7 | 7.1 | 6.6 | 10.6 | 15.2 | 20.8 | 18.5 |
| | 10.0 | 13.7 | 4.1 | 7.1 | 8.2 | 7.2 | 10.6 | 16.2 | 22.0 | 23.9 |
| 1C | 6.0 | 5.6 | 0.6 | 1.6 | 2.6 | 3.6 | 3.9 | 5.4 | 4.1 | 3.5 |
| | 7.0 | 8.0 | 0.5 | 2.2 | 2.6 | 4.1 | 4.7 | 7.2 | 6.7 | 9.9 |
| | 8.0 | 5.5 | 0.7 | 1.7 | 1.9 | 1.3 | 2.6 | 4.9 | 5.2 | 1.9 |
| | | 10.3 | 2.3 | 3.3 | 4.4 | 4.7 | 7.2 | 11.8 | 15.4 | 12.6 |
| | 8.5 | 10.7 | 4.3 | 3.3 | 4.7 | 5.4 | 7.2 | 11.3 | 17.3 | 15.5 |
| | 9.0 | 6.2 | 1.1 | 2.4 | 3.7 | 3.8 | 4.5 | 6.0 | 8.3 | 9.2 |
| | | 11.9 | 4.1 | 4.7 | 6.4 | 6.5 | 9.4 | 13.3 | 18.2 | 18.2 |
| | 10.0 | 13.7 | 5.8 | 8.7 | 8.7 | 7.4 | 10.4 | 13.1 | 21.1 | 22.8 |

(Continued)

Table 9 (Concluded)

| | Test Wave | | Wave Height, ft | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Plan | Period sec | Height ft | Gage 17 | Gage 18 | Gage 19 | Gage 20 | Gage 21 | Gage 22 | Gage 23 | Gage 24 | Gage 25 |
| 1 | 6.0 | 5.6 | 2.9 | 1.8 | 1.1 | 0.3 | 0.5 | 0.3 | 0.9 | 0.4 | 1.6 |
| | 7.0 | 8.0 | 4.9 | 1.1 | 1.1 | 1.1 | 1.4 | 0.6 | 1.1 | 0.8 | 2.2 |
| | 8.0 | 5.5 | 4.3 | 1.5 | 0.9 | 1.6 | 0.5 | 0.6 | 0.3 | 0.7 | 2.1 |
| | | 10.3 | 7.8 | 3.2 | 1.7 | 4.3 | 1.2 | 2.5 | 1.0 | 2.0 | 5.5 |
| | 8.5 | 10.7 | 8.4 | 6.3 | 4.5 | 6.2 | 1.3 | 2.8 | 1.9 | 3.2 | 6.1 |
| | 9.0 | 6.2 | 3.4 | 3.1 | 1.8 | 2.1 | 0.7 | 1.5 | 0.6 | 0.7 | 1.8 |
| | | 11.9 | 6.3 | 6.3 | 4.2 | 4.9 | 2.0 | 3.1 | 3.0 | 3.0 | 4.7 |
| | 10.0 | 13.7 | 7.2 | 6.1 | 4.3 | 5.9 | 2.6 | 3.3 | 2.2 | 2.7 | 4.7 |
| 1A | 6.0 | 5.6 | 2.4 | 1.4 | 0.2 | 0.3 | 0.6 | 0.6 | 0.6 | 0.6 | 0.3 |
| | 7.0 | 8.0 | 4.4 | 1.3 | 1.1 | 0.8 | 1.6 | 1.0 | 0.8 | 0.7 | 2.3 |
| | 8.0 | 5.5 | 3.7 | 0.9 | 0.5 | 0.6 | 0.4 | 0.4 | 0.3 | 0.6 | 0.4 |
| | 10.3 | 7.2 | 7.2 | 3.8 | 1.9 | 3.4 | 1.2 | 1.6 | 1.4 | 1.3 | 3.7 |
| | 8.5 | 10.7 | 8.4 | 5.5 | 3.2 | 6.6 | 1.5 | 2.1 | 1.8 | 3.0 | 5.0 |
| | 9.0 | 6.2 | 3.8 | 3.1 | 2.2 | 2.6 | 1.4 | 1.2 | 0.8 | 1.3 | 1.9 |
| | | 11.9 | 8.0 | 7.9 | 5.2 | 6.5 | 2.3 | 2.7 | 3.7 | 4.0 | 6.0 |
| | 10.0 | 13.7 | 11.0 | 7.3 | 4.6 | 7.5 | 3.6 | 3.8 | 3.3 | 4.6 | 5.7 |
| 1B | 6.0 | 5.6 | 3.4 | 0.7 | 0.5 | 0.2 | 0.5 | 0.5 | 0.5 | 0.6 | 1.2 |
| | 7.0 | 8.0 | 4.6 | 1.3 | 1.1 | 1.3 | 1.3 | 1.0 | 2.4 | 1.0 | 1.9 |
| | 8.0 | 5.5 | 3.4 | 1.1 | 0.7 | 0.4 | 0.3 | 0.3 | 0.5 | 0.3 | 0.8 |
| | | 10.3 | 9.1 | 5.2 | 2.9 | 3.4 | 1.4 | 2.3 | 2.0 | 1.6 | 5.2 |
| | 8.5 | 10.7 | 8.6 | 4.4 | 2.7 | 4.0 | 1.2 | 1.6 | 1.7 | 2.6 | 4.9 |
| | 9.0 | 6.2 | 4.0 | 3.6 | 2.0 | 2.8 | 1.2 | 1.8 | 0.5 | 0.7 | 2.5 |
| | | 11.9 | 7.5 | 6.0 | 3.4 | 4.8 | 2.2 | 2.9 | 2.8 | 3.1 | 4.6 |
| | 10.0 | 13.7 | 12.0 | 6.2 | 4.6 | 6.0 | 3.0 | 3.9 | 2.6 | 4.0 | 4.0 |
| 1C | 6.0 | 5.6 | 3.7 | 1.0 | 0.6 | 0.6 | 1.0 | 0.4 | 1.2 | 0.4 | 1.9 |
| | 7.0 | 8.0 | 3.8 | 1.9 | 1.9 | 1.5 | 2.2 | 1.4 | 1.1 | 0.9 | 2.8 |
| | 8.0 | 5.5 | 2.3 | 0.8 | 0.6 | 0.6 | 0.6 | 0.8 | 0.5 | 0.9 | 0.5 |
| | | 10.3 | 7.3 | 4.5 | 2.8 | 2.8 | 1.2 | 1.6 | 2.5 | 1.4 | 3.8 |
| | 8.5 | 10.7 | 8.8 | 5.0 | 3.2 | 5.0 | 1.7 | 2.4 | 2.5 | 3.8 | 6.0 |
| | 9.0 | 6.2 | 3.8 | 3.5 | 1.6 | 2.5 | 1.4 | 1.8 | 1.3 | 1.7 | 3.7 |
| | | 11.9 | 8.7 | 7.1 | 4.4 | 6.3 | 2.9 | 3.3 | 2.8 | 4.7 | 5.3 |
| | 10.0 | 13.7 | 10.1 | 6.7 | 5.2 | 6.8 | 3.2 | 3.2 | 2.5 | 3.9 | 4.8 |

Table 10

Wave Heights for Fair-Weather Plans 2-2C for Test Waves from 326 deg, +2.6 ft swl, River Discharge 800 cfs

| | Test Wave | | Wave Height, ft | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Plan | Period sec | Height ft | Gage 1 | Gage 2 | Gage 3 | Gage 4 | Gage 5 | Gage 6 | Gage 7 | Gage 8 |
| 2 | 6.0 | 5.6 | 0.5 | 0.2 | 0.3 | 0.3 | 0.4 | 0.4 | 1.5 | 0.3 |
| | 7.0 | 8.0 | 1.1 | 1.5 | 0.9 | 0.9 | 1.3 | 1.4 | 3.1 | 1.2 |
| | 8.0 | 5.5 | 0.8 | 0.7 | 0.6 | 0.3 | 0.3 | 0.7 | 2.2 | 0.7 |
| | | 10.3 | 2.7 | 2.7 | 2.4 | 2.1 | 2.9 | 2.5 | 4.8 | 3.8 |
| | 8.5 | 10.7 | 3.0 | 3.1 | 4.6 | 2.9 | 3.8 | 3.4 | 5.1 | 5.0 |
| | 9.0 | 6.2 | 1.5 | 0.9 | 1.4 | 0.9 | 0.6 | 1.3 | 1.5 | 0.6 |
| | | 11.9 | 3.3 | 4.5 | 5.9 | 3.7 | 4.3 | 4.2 | 5.3 | 4.7 |
| | 10.0 | 13.7 | 5.2 | 4.6 | 5.0 | 5.9 | 3.9 | 4.2 | 6.1 | 5.1 |
| 2A | 6.0 | 5.6 | 0.4 | 0.4 | 0.1 | 0.6 | 0.1 | 0.3 | 1.9 | 0.4 |
| | 7.0 | 8.0 | 1.2 | 1.4 | 0.9 | 1.2 | 1.4 | 0.9 | 3.5 | 0.9 |
| | 8.0 | 5.5 | 1.0 | 0.5 | 0.3 | 0.4 | 0.7 | 0.3 | 1.9 | 0.5 |
| | | 10.3 | 3.1 | 2.2 | 2.4 | 1.6 | 2.2 | 2.5 | 4.6 | 3.2 |
| | 8.5 | 10.7 | 3.0 | 2.6 | 3.3 | 2.8 | 4.3 | 3.9 | 5.5 | 2.9 |
| | 9.0 | 6.2 | 2.0 | 1.4 | 1.8 | 1.5 | 1.1 | 1.5 | 1.9 | 1.7 |
| | | 11.9 | 5.3 | 4.1 | 7.7 | 3.6 | 4.4 | 5.0 | 6.1 | 5.7 |
| | 10.0 | 13.7 | 6.2 | 7.2 | 6.6 | 5.5 | 6.9 | 5.9 | 6.4 | 5.2 |
| 2B | 6.0 | 5.6 | 0.4 | 0.5 | 0.2 | 0.5 | 0.5 | 0.7 | 2.2 | 0.5 |
| | 7.0 | 8.0 | 0.7 | 1.0 | 0.8 | 1.2 | 1.4 | 1.3 | 3.6 | 1.2 |
| | 8.0 | 5.5 | 0.7 | 0.9 | 0.3 | 0.3 | 0.7 | 0.3 | 1.5 | 0.7 |
| | | 10.3 | 1.5 | 1.9 | 1.8 | 1.4 | 2.3 | 2.1 | 4.4 | 2.4 |
| | 8.5 | 10.7 | 3.2 | 2.8 | 3.0 | 2.2 | 3.9 | 3.4 | 4.8 | 3.2 |
| | 9.0 | 6.2 | 1.1 | 0.9 | 1.0 | 0.9 | 1.1 | 1.5 | 2.5 | 1.3 |
| | | 11.9 | 3.7 | 4.9 | 4.3 | 3.2 | 4.8 | 5.5 | 5.5 | 4.3 |
| | 10.0 | 13.7 | 5.6 | 5.8 | 4.9 | 5.0 | 4.3 | 5.5 | 6.4 | 4.8 |
| 2C | 6.0 | 5.6 | 0.5 | 0.4 | 0.4 | 0.5 | 0.4 | 0.7 | 1.6 | 0.4 |
| | 7.0 | 8.0 | 0.8 | 1.2 | 0.7 | 1.0 | 0.5 | 0.6 | 3.4 | 0.7 |
| | 8.0 | 5.5 | 1.0 | 0.9 | 0.5 | 0.4 | 0.8 | 0.5 | 1.9 | 0.7 |
| | | 10.3 | 1.5 | 1.3 | 1.6 | 1.2 | 2.9 | 2.3 | 5.0 | 2.9 |
| | 8.5 | 10.7 | 3.0 | 3.1 | 2.9 | 2.5 | 3.1 | 4.4 | 5.6 | 3.0 |
| | 9.0 | 6.2 | 1.9 | 0.9 | 1.6 | 1.5 | 1.1 | 1.9 | 3.1 | 1.1 |
| | | 11.9 | 4.3 | 4.4 | 5.0 | 3.5 | 4.0 | 4.3 | 5.9 | 5.4 |
| | 10.0 | 13.7 | 5.3 | 7.1 | 5.8 | 6.7 | 5.8 | 5.7 | 7.4 | 6.6 |

(Continued)

Table 10 (Continued)

| Test Wave | | | Wave Height, ft | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Plan | Period sec | Height ft | Gage 9 | Gage 10 | Gage 11 | Gage 12 | Gage 13 | Gage 14 | Gage 15 | Gage 16 |
| 2 | 6.0 | 5.6 | 0.4 | 2.0 | 2.2 | 3.1 | 3.7 | 5.6 | 4.5 | 3.2 |
| | 7.0 | 8.0 | 1.2 | 2.4 | 2.7 | 4.6 | 6.0 | 8.5 | 8.0 | 12.8 |
| | 8.0 | 5.5 | 0.8 | 1.2 | 2.3 | 2.5 | 3.2 | 3.7 | 5.3 | 3.8 |
| | | 10.3 | 3.5 | 3.3 | 4.8 | 5.7 | 8.7 | 10.2 | 14.2 | 12.9 |
| | 8.5 | 10.7 | 3.2 | 3.3 | 5.5 | 5.9 | 7.6 | 11.8 | 16.3 | 15.4 |
| | 9.0 | 6.2 | 1.1 | 1.7 | 3.3 | 2.5 | 3.4 | 4.9 | 5.6 | 4.2 |
| | | 11.9 | 3.5 | 4.5 | 6.0 | 6.1 | 8.4 | 11.5 | 16.1 | 16.4 |
| | 10.0 | 13.7 | 4.0 | 6.4 | 7.3 | 6.3 | 9.7 | 11.2 | 16.2 | 24.2 |
| 2A | 6.0 | 5.6 | 0.5 | 1.8 | 1.7 | 2.9 | 3.1 | 4.1 | 4.9 | 3.8 |
| | 7.0 | 8.0 | 1.2 | 2.0 | 1.8 | 3.8 | 4.7 | 6.9 | 5.9 | 10.6 |
| | 8.0 | 5.5 | 0.8 | 2.0 | 1.9 | 2.5 | 2.9 | 5.9 | 6.9 | 2.7 |
| | 10.3 | 7.2 | 2.2 | 3.4 | 4.6 | 4.9 | 10.2 | 10.8 | 10.6 | 7.2 |
| | 8.5 | 10.7 | 3.6 | 3.3 | 5.0 | 5.6 | 9.6 | 13.7 | 17.4 | 13.2 |
| | 9.0 | 6.2 | 1.9 | 2.2 | 3.1 | 2.6 | 3.1 | 6.1 | 6.2 | 6.6 |
| | | 11.9 | 3.1 | 4.8 | 6.4 | 6.1 | 9.5 | 13.9 | 19.8 | 21.2 |
| | 10.0 | 13.7 | 4.1 | 7.6 | 7.9 | 6.4 | 10.2 | 16.5 | 24.1 | 2.40 |
| 2B | 6.0 | 5.6 | 0.6 | 2.1 | 2.0 | 3.2 | 3.5 | 4.3 | 4.3 | 4.1 |
| | 7.0 | 8.0 | 0.7 | 2.3 | 2.0 | 3.8 | 4.9 | 6.3 | 6.3 | 10.9 |
| | 8.0 | 5.5 | 0.5 | 1.2 | 1.8 | 2.2 | 2.7 | 4.5 | 3.5 | 2.4 |
| | | 10.3 | 2.4 | 3.8 | 4.6 | 5.0 | 6.9 | 11.2 | 13.5 | 10.7 |
| | 8.5 | 10.7 | 3.0 | 2.7 | 4.5 | 4.7 | 7.6 | 11.4 | 14.4 | 14.6 |
| | 9.0 | 6.2 | 1.7 | 1.6 | 3.4 | 3.3 | 3.7 | 5.8 | 6.7 | 5.1 |
| | | 11.9 | 3.5 | 3.9 | 6.8 | 6.4 | 9.7 | 14.0 | 20.1 | 15.5 |
| | 10.0 | 13.7 | 4.3 | 6.9 | 8.0 | 6.8 | 10.1 | 16.1 | 20.4 | 23.0 |
| 2C | 6.0 | 5.6 | 0.5 | 1.4 | 2.4 | 3.5 | 4.0 | 5.0 | 4.1 | 3.0 |
| | 7.0 | 8.0 | 0.7 | 1.8 | 2.0 | 3.9 | 4.6 | 6.7 | 7.0 | 9.9 |
| | 8.0 | 5.5 | 0.7 | 1.4 | 1.8 | 1.2 | 2.3 | 4.5 | 5.0 | 2.4 |
| | | 10.3 | 2.3 | 3.6 | 4.7 | 5.1 | 7.1 | 11.0 | 11.7 | 10.5 |
| | 8.5 | 10.7 | 4.9 | 3.0 | 4.7 | 5.7 | 7.8 | 11.9 | 17.2 | 13.8 |
| | 9.0 | 6.2 | 1.5 | 2.1 | 3.3 | 3.3 | 4.2 | 5.5 | 7.7 | 7.7 |
| | | 11.9 | 3.7 | 4.1 | 5.6 | 5.6 | 8.2 | 12.1 | 19.5 | 15.8 |
| | 10.0 | 13.7 | 5.2 | 7.5 | 8.0 | 6.2 | 9.4 | 13.7 | 22.1 | 20.8 |

(Continued)

Table 10 (Concluded)

| Test Wave | | | Wave Height, ft | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Plan | Period sec | Height ft | Gage 17 | Gage 18 | Gage 19 | Gage 20 | Gage 21 | Gage 22 | Gage 23 | Gage 24 | Gage 25 |
| 2 | 6.0 | 5.6 | 2.7 | 1.1 | 0.4 | 1.1 | 0.5 | 0.4 | 0.6 | 0.5 | 1.5 |
| | 7.0 | 8.0 | 4.5 | 1.3 | 1.6 | 1.0 | 1.3 | 0.9 | 1.2 | 0.7 | 2.2 |
| | 8.0 | 5.5 | 3.9 | 1.5 | 0.9 | 1.5 | 0.6 | 0.7 | 0.3 | 0.7 | 1.8 |
| | | 10.3 | 8.5 | 2.8 | 1.4 | 4.5 | 1.3 | 2.8 | 1.2 | 1.8 | 4.8 |
| | 8.5 | 10.7 | 6.7 | 4.0 | 2.6 | 5.7 | 1.3 | 2.3 | 1.8 | 2.8 | 4.9 |
| | 9.0 | 6.2 | 2.4 | 2.3 | 1.4 | 1.8 | 0.4 | 1.3 | 0.6 | 0.9 | 1.6 |
| | | 11.9 | 5.8 | 4.9 | 3.4 | 4.4 | 2.5 | 3.5 | 2.7 | 2.5 | 3.1 |
| | 10.0 | 13.7 | 7.5 | 7.3 | 4.9 | 5.0 | 3.3 | 4.5 | 2.7 | 3.1 | 4.6 |
| 2A | 6.0 | 5.6 | 3.0 | 1.6 | 0.2 | 0.4 | 0.6 | 0.7 | 0.5 | 0.5 | 0.7 |
| | 7.0 | 8.0 | 4.1 | 1.6 | 1.3 | 1.0 | 1.8 | 1.1 | 0.9 | 0.9 | 2.5 |
| | 8.0 | 5.5 | 3.1 | 1.1 | 0.5 | 0.3 | 0.3 | 0.5 | 0.3 | 0.6 | 0.5 |
| | | 10.3 | 7.2 | 2.7 | 1.7 | 2.2 | 1.2 | 1.6 | 1.5 | 1.3 | 3.5 |
| | 8.5 | 10.7 | 8.2 | 5.4 | 3.0 | 5.1 | 1.2 | 2.8 | 1.9 | 2.3 | 4.0 |
| | 9.0 | 6.2 | 3.6 | 3.7 | 2.3 | 2.4 | 0.9 | 1.4 | 0.6 | 0.8 | 2.3 |
| | | 11.9 | 7.4 | 7.0 | 4.8 | 5.7 | 2.5 | 3.3 | 3.6 | 3.5 | 4.0 |
| | 10.0 | 13.7 | 9.9 | 9.0 | 5.3 | 9.7 | 4.4 | 4.8 | 3.1 | 5.3 | 5.3 |
| 2B | 6.0 | 5.6 | 3.4 | 1.0 | 0.7 | 0.3 | 0.4 | 0.2 | 0.3 | 0.4 | 1.0 |
| | 7.0 | 8.0 | 4.0 | 1.3 | 1.4 | 1.1 | 1.5 | 1.2 | 2.1 | 0.9 | 1.8 |
| | 8.0 | 5.5 | 3.2 | 1.1 | 0.8 | 0.7 | 0.4 | 0.5 | 0.4 | 0.3 | 1.1 |
| | | 10.3 | 9.0 | 3.9 | 2.5 | 3.1 | 1.5 | 2.1 | 1.7 | 1.8 | 4.5 |
| | 8.5 | 10.7 | 8.1 | 4.6 | 2.9 | 4.3 | 1.2 | 1.9 | 2.1 | 2.8 | 3.5 |
| | 9.0 | 6.2 | 3.7 | 1.9 | 1.0 | 1.6 | 0.5 | 1.0 | 0.9 | 1.0 | 1.6 |
| | | 11.9 | 8.8 | 5.6 | 3.3 | 3.9 | 1.8 | 2.7 | 2.6 | 2.9 | 4.1 |
| | 10.0 | 13.7 | 10.4 | 6.7 | 4.9 | 6.1 | 3.2 | 4.0 | 2.5 | 3.1 | 4.6 |
| 2C | 6.0 | 5.6 | 3.9 | 1.2 | 0.8 | 0.7 | 1.0 | 0.2 | 1.0 | 0.4 | 1.4 |
| | 7.0 | 8.0 | 3.8 | 1.7 | 1.5 | 1.3 | 1.4 | 1.0 | 0.9 | 0.7 | 1.6 |
| | 8.0 | 5.5 | 1.9 | 0.6 | 0.8 | 0.4 | 0.6 | 0.4 | 0.7 | 0.6 | 0.5 |
| | | 10.3 | 6.7 | 3.1 | 2.6 | 2.3 | 1.2 | 1.6 | 2.7 | 1.3 | 3.7 |
| | 8.5 | 10.7 | 8.3 | 5.6 | 3.4 | 5.3 | 2.3 | 2.4 | 2.5 | 2.4 | 4.6 |
| | 9.0 | 6.2 | 3.2 | 3.2 | 1.3 | 1.5 | 1.0 | 1.4 | 0.9 | 1.0 | 3.8 |
| | | 11.9 | 7.2 | 6.0 | 4.0 | 5.3 | 3.1 | 3.6 | 2.2 | 3.3 | 3.8 |
| | 10.0 | 13.7 | 9.7 | 11.6 | 7.5 | 8.4 | 4.5 | 5.9 | 3.9 | 4.0 | 5.7 |

(Sheet 3 of 3)

Table 11

Wave Heights for Fair-Weather Plans 1A, 2A, and 3-4C for Test Waves from 279 deg, +2.6 ft swl, River Discharge 800 cfs

| | Test Wave | | Wave Height, ft | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Plan | Period sec | Height ft | Gage 1 | Gage 2 | Gage 3 | Gage 4 | Gage 5 | Gage 6 | Gage 7 | Gage 8 |
| 1A | 6.0 | 3.9 | 0.2 | 0.2 | 0.2 | 0.4 | 0.1 | 0.2 | 0.2 | 0.3 |
| | 7.0 | 5.5 | 0.3 | 0.6 | 0.4 | 0.7 | 0.5 | 0.5 | 0.7 | 0.4 |
| | 8.0 | 6.6 | 0.9 | 0.5 | 0.4 | 0.7 | 0.6 | 0.3 | 0.7 | 0.5 |
| | 9.0 | 4.3 | 0.2 | 0.5 | 0.5 | 0.6 | 0.2 | 0.3 | 0.1 | 0.5 |
| | | 8.1 | 2.2 | 1.6 | 2.2 | 1.7 | 0.9 | 1.1 | 1.4 | 2.1 |
| | | 8.6 | 3.1 | 2.9 | 2.4 | 1.9 | 1.1 | 1.7 | 1.7 | 1.8 |
| | 10.0 | 9.2 | 3.0 | 2.8 | 3.4 | 3.2 | 2.6 | 2.4 | 2.0 | 2.5 |
| 2A | 6.0 | 3.9 | 0.2 | 0.2 | 0.2 | 0.3 | 0.1 | 0.2 | 0.1 | 0.4 |
| | 7.0 | 5.5 | 0.2 | 0.4 | 0.3 | 0.6 | 0.5 | 0.5 | 0.5 | 0.5 |
| | 8.0 | 6.6 | 1.1 | 0.7 | 0.5 | 0.6 | 0.5 | 0.3 | 0.7 | 0.5 |
| | 9.0 | 4.3 | 0.3 | 0.5 | 0.7 | 0.7 | 0.3 | 0.3 | 0.3 | 0.5 |
| | | 8.1 | 2.5 | 1.8 | 2.1 | 1.7 | 0.8 | 1.0 | 1.3 | 2.0 |
| | | 8.6 | 2.7 | 2.0 | 3.1 | 1.7 | 1.4 | 1.6 | 1.7 | 2.0 |
| | 10.0 | 9.2 | 2.9 | 1.9 | 3.0 | 2.6 | 2.5 | 2.2 | 2.7 | 3.0 |
| 3 | 6.0 | 3.9 | 0.3 | 0.2 | 0.2 | 0.3 | 0.2 | <0.1 | 0.3 | 0.3 |
| | 7.0 | 5.5 | 0.2 | 0.3 | 0.2 | 0.4 | 0.6 | 0.2 | 0.2 | 0.4 |
| | 8.0 | 6.6 | 0.8 | 0.8 | 0.8 | 0.5 | 0.4 | 0.5 | 0.6 | 0.9 |
| | 9.0 | 4.3 | 0.4 | 1.0 | 0.5 | 0.7 | 0.5 | 0.5 | 0.7 | 0.6 |
| | | 8.1 | 3.2 | 2.3 | 1.8 | 1.9 | 1.5 | 1.0 | 2.0 | 1.7 |
| | | 8.6 | 2.0 | 1.8 | 1.5 | 1.6 | 0.9 | 1.3 | 1.7 | 2.3 |
| | 10.0 | 9.2 | 2.4 | 1.9 | 3.5 | 1.7 | 1.3 | 2.3 | 2.3 | 1.8 |
| 3A | 9.0 | 8.6 | 2.1 | 1.7 | 2.2 | 1.6 | 1.2 | 1.0 | 2.7 | 2.0 |
| | 10.0 | 9.2 | 2.6 | 2.3 | 3.3 | 2.6 | 2.5 | 2.3 | 2.9 | 2.5 |
| 3B | 9.0 | 8.6 | 2.6 | 1.9 | 2.1 | 1.8 | 1.3 | 1.4 | 2.6 | 3.0 |
| | 10.0 | 9.2 | 3.0 | 2.7 | 3.2 | 3.0 | 3.0 | 2.6 | 2.1 | 3.2 |
| 3C | 9.0 | 8.6 | 2.0 | 2.5 | 1.6 | 1.5 | 1.1 | 2.1 | 1.9 | 2.3 |
| | 10.0 | 9.2 | 3.2 | 3.1 | 3.3 | 3.2 | 2.8 | 3.1 | 3.0 | 2.2 |
| 3D | 9.0 | 8.6 | 2.6 | 2.4 | 1.8 | 1.3 | 1.2 | 2.1 | 1.5 | 2.2 |
| | 10.0 | 9.2 | 2.2 | 2.9 | 2.2 | 2.4 | 2.4 | 2.7 | 1.8 | 2.4 |
| 4 | 9.0 | 8.6 | 3.3 | 2.0 | 2.3 | 1.5 | 0.9 | 1.2 | 1.0 | 2.1 |
| | 10.0 | 9.2 | 2.4 | 2.4 | 2.0 | 2.2 | 2.3 | 1.9 | 2.3 | 2.1 |
| 4A | 9.0 | 8.6 | 2.5 | 2.0 | 2.1 | 1.3 | 1.3 | 1.2 | 2.0 | 2.3 |
| | 10.0 | 9.2 | 2.7 | 1.7 | 2.9 | 2.2 | 2.1 | 2.1 | 2.0 | 2.2 |
| 4B | 9.0 | 8.6 | 2.2 | 2.5 | 2.2 | 1.5 | 1.1 | 1.2 | 2.1 | 2.9 |
| | 10.0 | 9.2 | 2.8 | 2.5 | 2.1 | 2.0 | 3.2 | 2.6 | 2.0 | 1.9 |
| 4C | 9.0 | 8.6 | 1.6 | 1.2 | 1.9 | 1.5 | 0.8 | 1.1 | 1.0 | 1.9 |
| | 10.0 | 9.2 | 2.6 | 2.2 | 3.3 | 2.3 | 1.4 | 2.2 | 2.2 | 2.3 |

(Continued)

Table 11 (Continued)

| | Test Wave | | Wave Height, ft | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Plan | Period sec | Height ft | Gage 9 | Gage 10 | Gage 11 | Gage 12 | Gage 13 | Gage 14 | Gage 15 | Gage 16 |
| 1A | 6.0 | 3.9 | 0.2 | 0.4 | 0.4 | 0.4 | 1.1 | 1.3 | 1.7 | 1.5 |
| | 7.0 | 5.5 | 0.2 | 1.0 | 0.4 | 1.2 | 1.0 | 2.4 | 2.2 | 4.7 |
| | 8.0 | 6.6 | 0.6 | 1.0 | 0.3 | 1.0 | 1.3 | 2.0 | 1.9 | 5.9 |
| | 9.0 | 4.3 | 0.5 | 0.1 | 1.2 | 0.8 | 1.8 | 1.8 | 2.2 | 4.9 |
| | | 8.1 | 1.0 | 0.9 | 3.0 | 2.4 | 2.0 | 5.1 | 5.2 | 10.1 |
| | | 8.6 | 1.2 | 1.8 | 2.2 | 1.7 | 1.1 | 5.1 | 4.5 | 10.4 |
| | 10.0 | 9.2 | 2.4 | 4.1 | 4.8 | 4.2 | 4.3 | 5.8 | 7.2 | 9.9 |
| 2A | 6.0 | 3.9 | 0.1 | 0.3 | 0.3 | 0.5 | 0.6 | 1.0 | 2.1 | 1.1 |
| | 7.0 | 5.5 | 0.3 | 0.7 | 0.6 | 0.9 | 0.6 | 1.5 | 2.6 | 4.6 |
| | 8.0 | 6.6 | 0.7 | 0.4 | 0.5 | 0.4 | 0.5 | 1.1 | 1.4 | 6.8 |
| | 9.0 | 4.3 | 0.4 | 0.3 | 0.8 | 0.4 | 0.9 | 1.2 | 1.9 | 5.7 |
| | | 8.1 | 1.0 | 0.7 | 1.7 | 1.6 | 2.0 | 3.4 | 5.9 | 9.1 |
| | | 8.6 | 1.4 | 1.4 | 2.3 | 1.7 | 2.9 | 3.5 | 4.6 | 7.9 |
| | 10.0 | 9.2 | 2.3 | 3.2 | 3.8 | 4.4 | 3.0 | 4.5 | 6.4 | 8.6 |
| 3 | 6.0 | 3.9 | <0.1 | 0.5 | 0.2 | 0.2 | 0.6 | 1.0 | 1.1 | 1.6 |
| | 7.0 | 5.5 | 0.4 | 0.4 | 0.4 | 0.3 | 1.3 | 1.3 | 2.4 | 3.3 |
| | 8.0 | 6.6 | 0.5 | 1.0 | 1.4 | 1.3 | 1.5 | 2.0 | 1.9 | 4.8 |
| | 9.0 | 4.3 | 0.5 | 0.2 | 0.7 | 0.5 | 1.6 | 2.4 | 1.9 | 4.3 |
| | | 8.1 | 1.4 | 1.4 | 3.1 | 1.8 | 2.4 | 3.2 | 5.6 | 10.5 |
| | | 8.6 | 1.8 | 1.4 | 2.3 | 1.6 | 2.4 | 1.9 | 5.2 | 9.7 |
| | 10.0 | 9.2 | 2.2 | 3.2 | 2.9 | 2.2 | 4.5 | 4.1 | 5.8 | 7.0 |
| 3A | 9.0 | 8.6 | 1.3 | 1.4 | 3.2 | 1.6 | 3.1 | 2.7 | 5.9 | 8.4 |
| | 10.0 | 9.2 | 2.3 | 2.4 | 3.4 | 3.4 | 4.7 | 4.1 | 7.0 | 7.9 |
| 3B | 9.0 | 8.6 | 1.7 | 1.3 | 2.1 | 1.4 | 3.3 | 3.0 | 4.8 | 7.7 |
| | 10.0 | 9.2 | 3.5 | 2.2 | 3.1 | 3.1 | 4.0 | 4.4 | 4.4 | 5.7 |
| 3C | 9.0 | 8.6 | 1.3 | 1.5 | 1.7 | 2.1 | 2.0 | 4.4 | 2.5 | 5.8 |
| | 10.0 | 9.2 | 4.0 | 2.1 | 3.9 | 3.0 | 4.9 | 3.1 | 7.0 | 6.2 |
| 3D | 9.0 | 8.6 | 1.3 | 1.1 | 1.5 | 2.0 | 1.6 | 4.1 | 3.1 | 6.4 |
| | 10.0 | 9.2 | 2.6 | 1.7 | 2.8 | 2.9 | 3.5 | 4.8 | 3.5 | 4.1 |
| 4 | 9.0 | 8.6 | 1.4 | 1.0 | 1.4 | 1.0 | 1.5 | 2.5 | 3.5 | 6.3 |
| | 10.0 | 9.2 | 2.2 | 1.5 | 1.7 | 1.6 | 1.9 | 2.8 | 4.1 | 5.4 |
| 4A | 9.0 | 8.6 | 1.8 | 1.1 | 1.7 | 1.9 | 1.6 | 2.3 | 3.7 | 7.6 |
| | 10.0 | 9.2 | 2.1 | 1.6 | 1.9 | 2.0 | 1.7 | 3.5 | 3.7 | 5.8 |
| 4B | 9.0 | 8.6 | 2.1 | 1.5 | 2.5 | 2.0 | 2.4 | 3.2 | 3.6 | 6.0 |
| | 10.0 | 9.2 | 2.5 | 1.6 | 2.1 | 2.7 | 4.0 | 5.6 | 6.6 | 8.3 |
| 4C | 9.0 | 8.6 | 1.4 | 1.1 | 1.8 | 1.3 | 1.3 | 2.3 | 3.2 | 7.4 |
| | 10.0 | 9.2 | 2.0 | 2.5 | 2.4 | 2.1 | 1.5 | 3.8 | 5.0 | 7.2 |

(Continued)

Table 11 (Concluded)

| Plan | Test Wave Period sec | Test Wave Height ft | Gage 17 | Gage 18 | Gage 19 | Gage 20 | Gage 21 | Gage 22 | Gage 23 | Gage 24 | Gage 25 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Wave Height, ft | | | | | | | | |
| 1A | 6.0 | 3.9 | 0.4 | 1.5 | 0.5 | 0.6 | 0.4 | 0.3 | 0.5 | 0.5 | 0.7 |
| | 7.0 | 5.5 | 1.7 | 1.0 | 1.0 | 0.6 | 0.5 | 1.1 | 1.0 | 0.7 | 0.6 |
| | 8.0 | 6.6 | 1.2 | 1.8 | 1.6 | 1.2 | 0.4 | 1.5 | 0.7 | 0.5 | 1.8 |
| | 9.0 | 4.3 | 1.3 | 1.7 | 0.6 | 1.3 | 0.8 | 0.9 | 0.2 | 0.7 | 1.7 |
| | | 8.1 | 2.1 | 4.6 | 2.7 | 2.3 | 1.8 | 2.0 | 1.2 | 1.7 | 2.9 |
| | | 8.6 | 1.5 | 5.9 | 2.8 | 5.1 | 2.2 | 2.7 | 1.6 | 1.8 | 1.9 |
| | 10.0 | 9.2 | 2.5 | 5.9 | 4.6 | 5.8 | 2.2 | 5.5 | 2.5 | 4.0 | 4.1 |
| 2A | 6.0 | 3.9 | 1.0 | 1.5 | 0.4 | 0.6 | 0.9 | 0.6 | 0.4 | 0.6 | 0.7 |
| | 7.0 | 5.5 | 0.9 | 0.9 | 0.8 | 0.3 | 0.9 | 0.7 | 0.7 | 0.5 | 0.5 |
| | 8.0 | 6.6 | 0.4 | 1.7 | 1.5 | 1.2 | 0.4 | 1.5 | 0.8 | 0.5 | 1.7 |
| | 9.0 | 4.3 | 1.0 | 2.1 | 0.7 | 1.2 | 1.0 | 1.1 | 0.4 | 0.7 | 1.8 |
| | | 8.1 | 1.7 | 4.0 | 1.9 | 3.3 | 2.4 | 2.0 | 0.7 | 1.3 | 3.1 |
| | | 8.6 | 1.8 | 4.7 | 2.1 | 3.5 | 1.4 | 2.1 | 1.6 | 1.4 | 1.6 |
| | 10.0 | 9.2 | 2.5 | 3.7 | 2.5 | 3.6 | 2.0 | 4.3 | 1.9 | 4.4 | 4.6 |
| 3 | 6.0 | 3.9 | 0.7 | 1.5 | 0.4 | 0.7 | 1.2 | 0.5 | 0.1 | 0.1 | 0.2 |
| | 7.0 | 5.5 | 1.3 | 1.0 | 0.8 | 0.7 | 0.3 | 0.6 | 0.4 | 0.4 | 0.6 |
| | 8.0 | 6.6 | 1.1 | 2.4 | 1.8 | 1.3 | 0.6 | 0.9 | 0.9 | 0.5 | 0.9 |
| | 9.0 | 4.3 | 1.5 | 1.7 | 0.6 | 0.4 | 1.0 | 0.7 | 0.3 | 0.4 | 1.2 |
| | | 8.1 | 1.4 | 5.0 | 2.9 | 3.8 | 0.9 | 1.1 | 1.6 | 1.8 | 1.0 |
| | | 8.6 | 2.3 | 4.8 | 3.0 | 4.1 | 2.0 | 1.6 | 1.4 | 2.0 | 2.0 |
| | 10.0 | 9.2 | 4.2 | 5.7 | 3.7 | 5.3 | 2.0 | 3.1 | 1.2 | 3.5 | 2.7 |
| 3A | 9.0 | 8.6 | 2.3 | 4.5 | 2.3 | 4.8 | 2.3 | 2.1 | 1.8 | 2.5 | 1.6 |
| | 10.0 | 9.2 | 3.6 | 5.0 | 3.6 | 6.2 | 2.7 | 3.9 | 2.0 | 3.9 | 3.6 |
| 3B | 9.0 | 8.6 | 2.8 | 4.1 | 2.0 | 4.5 | 2.2 | 2.1 | 1.9 | 1.5 | 2.9 |
| | 10.0 | 9.2 | 4.5 | 3.6 | 2.8 | 4.2 | 3.2 | 5.2 | 2.0 | 3.8 | 2.8 |
| 3C | 9.0 | 8.6 | 3.3 | 2.0 | 1.1 | 3.0 | 2.4 | 2.0 | 1.8 | 1.8 | 1.4 |
| | 10.0 | 9.2 | 3.5 | 4.0 | 2.6 | 4.1 | 2.3 | 4.5 | 1.7 | 4.3 | 2.2 |
| 3D | 9.0 | 8.6 | 2.8 | 2.8 | 1.5 | 3.4 | 2.2 | 2.3 | 1.7 | 1.7 | 1.6 |
| | 10.0 | 9.2 | 4.3 | 2.2 | 1.5 | 3.1 | 2.2 | 3.7 | 1.6 | 3.5 | 2.2 |
| 4 | 9.0 | 8.6 | 1.3 | 2.4 | 1.4 | 2.6 | 1.3 | 1.5 | 1.5 | 1.0 | 1.4 |
| | 10.0 | 9.2 | 2.7 | 3.1 | 2.5 | 2.9 | 1.3 | 3.3 | 1.4 | 2.9 | 3.0 |
| 4A | 9.0 | 8.6 | 1.3 | 2.6 | 1.6 | 2.2 | 0.8 | 0.9 | 0.9 | 1.3 | 1.1 |
| | 10.0 | 9.2 | 3.3 | 3.2 | 3.2 | 2.9 | 1.3 | 3.3 | 1.7 | 2.2 | 3.0 |
| 4B | 9.0 | 8.6 | 2.7 | 3.2 | 1.8 | 4.1 | 2.1 | 1.5 | 1.3 | 1.0 | 1.5 |
| | 10.0 | 9.2 | 4.5 | 4.5 | 3.3 | 5.3 | 2.7 | 4.7 | 1.6 | 5.2 | 3.7 |
| 4C | 9.0 | 8.6 | 1.8 | 3.1 | 1.7 | 2.6 | 1.0 | 1.5 | 1.3 | 1.0 | 1.0 |
| | 10.0 | 9.2 | 2.9 | 4.0 | 2.9 | 3.7 | 1.4 | 2.8 | 1.1 | 2.6 | 2.2 |

Table 12

Wave Heights for Fair-Weather Plans 1A, 2A, 4D, and 4E for Test Waves from 17 deg and Fair-Weather Plan 4D for Test Waves from 326 deg, +2.6 ft swl, River Discharge 800 cfs

| | Test Wave | | Wave Height, ft | | | | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Plan | Period sec | Height ft | Gage 1 | Gage 2 | Gage 3 | Gage 4 | Gage 5 | Gage 6 | Gage 7 | Gage 8 | Gage 9 | Gage 10 | Gage 11 | Gage 12 | Gage 13 | Gage 14 | Gage 15 | Gage 16 | Gage 17 | Gage 18 | Gage 19 | Gage 20 | Gage 21 | Gage 22 | Gage 23 | Gage 24 | Gage 25 |
| | | | | | | | | | | | | | 17 Degrees | | | | | | | | | | | | | | |
| 1A | 6.0 | 4.7 | 0.3 | 0.6 | 0.6 | 0.5 | 0.7 | 2.2 | 0.4 | 0.2 | 0.8 | 0.5 | 1.2 | 1.4 | 0.5 | 2.1 | 3.5 | 5.8 | 1.0 | 0.6 | 0.2 | 0.2 | 0.2 | 0.4 | 0.3 | 0.1 | 0.6 |
| | 7.0 | 7.3 | 0.9 | 0.7 | 1.0 | 0.7 | 1.5 | 2.6 | 2.6 | 0.8 | 2.3 | 0.9 | 0.9 | 3.1 | 3.4 | 2.5 | 4.7 | 10.1 | 2.2 | 0.6 | 0.2 | 0.4 | 0.8 | 0.6 | 0.5 | 0.4 | 1.1 |
| | 8.0 | 5.1 | 0.9 | 1.6 | 0.8 | 0.7 | 1.2 | 2.2 | 2.0 | 0.7 | 1.1 | 0.7 | 2.4 | 2.4 | 3.3 | 2.9 | 4.2 | 5.9 | 0.9 | 0.5 | 0.4 | 0.4 | 0.3 | 0.5 | 0.3 | 0.2 | 0.6 |
| | | 8.9 | 1.1 | 2.0 | 1.7 | 1.4 | 2.3 | 3.6 | 2.7 | 1.2 | 2.2 | 1.4 | 2.3 | 4.3 | 5.1 | 2.8 | 4.2 | 6.9 | 1.1 | 1.2 | 0.5 | 0.7 | 0.4 | 0.7 | 0.8 | 0.6 | 1.0 |
| | | 9.8 | 1.2 | 1.3 | 1.4 | 0.9 | 1.9 | 3.8 | 2.1 | 1.4 | 2.2 | 1.0 | 2.1 | 3.3 | 4.4 | 4.0 | 4.8 | 8.0 | 1.2 | 1.5 | 0.9 | 1.4 | 0.5 | 1.3 | 0.9 | 0.6 | 1.0 |
| | 9.5 | 12.2 | 4.5 | 5.0 | 4.6 | 3.6 | 3.6 | 5.1 | 5.0 | 3.8 | 3.6 | 2.7 | 4.7 | 6.4 | 7.2 | 7.4 | 12.1 | 22.4 | 5.7 | 2.8 | 2.3 | 3.5 | 1.4 | 1.9 | 0.8 | 1.4 | 2.1 |
| 2A | 6.0 | 4.7 | 0.2 | 0.5 | 0.5 | 0.7 | 0.9 | 2.3 | 0.4 | 0.2 | 0.7 | 0.5 | 0.7 | 1.1 | 0.9 | 1.2 | 2.9 | 5.5 | 1.0 | 0.7 | 0.3 | 0.1 | 0.2 | 0.5 | 0.4 | 0.1 | 0.3 |
| | 7.0 | 7.3 | 0.9 | 1.1 | 1.3 | 1.2 | 1.9 | 2.6 | 1.4 | 0.8 | 2.1 | 0.6 | 0.7 | 1.9 | 1.8 | 1.4 | 4.7 | 9.0 | 2.3 | 0.5 | 0.4 | 0.5 | 0.7 | 0.4 | 0.7 | 0.5 | 1.1 |
| | 8.0 | 5.1 | 0.8 | 2.3 | 0.9 | 0.6 | 1.2 | 1.5 | 2.3 | 0.4 | 1.9 | 0.9 | 1.7 | 1.8 | 1.8 | 2.3 | 4.0 | 5.3 | 1.3 | 0.5 | 0.4 | 0.4 | 0.3 | 0.4 | 0.3 | 0.3 | 0.8 |
| | | 8.9 | 1.6 | 2.9 | 1.8 | 1.0 | 2.0 | 2.9 | 2.8 | 0.9 | 3.0 | 1.5 | 1.8 | 3.3 | 2.8 | 2.3 | 4.3 | 6.0 | 1.9 | 1.0 | 0.9 | 1.1 | 0.5 | 1.0 | 0.4 | 0.5 | 1.2 |
| | | 9.8 | 2.0 | 3.1 | 2.2 | 1.5 | 2.0 | 3.0 | 2.9 | 1.0 | 3.0 | 2.0 | 1.6 | 3.6 | 2.7 | 2.6 | 3.9 | 7.0 | 2.1 | 1.3 | 0.9 | 1.3 | 0.7 | 1.1 | 1.0 | 0.7 | 1.8 |
| | 9.5 | 12.2 | 5.0 | 4.5 | 3.8 | 3.8 | 3.5 | 4.2 | 4.2 | 3.1 | 3.0 | 1.9 | 2.9 | 4.0 | 4.6 | 4.9 | 9.4 | 19.6 | 4.6 | 2.9 | 2.1 | 3.3 | 1.4 | 1.9 | 0.9 | 1.8 | 2.3 |
| 4D | 6.0 | 4.7 | 0.2 | 0.2 | 0.2 | 0.1 | 0.2 | 0.9 | 0.3 | 0.1 | 0.2 | 0.4 | 0.4 | 0.3 | 0.3 | 0.8 | 1.6 | 2.3 | 0.4 | 0.7 | 0.2 | 0.5 | 0.4 | 0.2 | 0.1 | 0.1 | 0.3 |
| | 7.0 | 7.3 | 0.6 | 0.4 | 0.4 | 0.4 | 0.7 | 1.4 | 0.8 | 0.6 | 0.8 | 0.5 | 0.9 | 0.6 | 1.1 | 2.2 | 2.2 | 5.5 | 0.5 | 0.2 | 0.2 | 0.3 | 0.3 | 0.2 | 0.5 | 0.2 | 0.7 |
| | 8.0 | 5.1 | 0.5 | 1.1 | 0.4 | 0.2 | 0.3 | 1.3 | 2.0 | 0.2 | 0.9 | 0.9 | 0.8 | 1.9 | 2.2 | 1.9 | 2.6 | 4.5 | 1.4 | 0.7 | 0.6 | 0.3 | 0.1 | 0.2 | 0.3 | 0.1 | 0.3 |
| | | 8.9 | 0.6 | 0.9 | 0.5 | 0.5 | 1.1 | 2.9 | 1.3 | 0.6 | 1.3 | 0.7 | 1.4 | 2.3 | 3.1 | 3.5 | 3.9 | 6.3 | 1.7 | 1.6 | 0.9 | 0.7 | 0.3 | 0.5 | 0.5 | 0.5 | 0.8 |
| | | 9.8 | 1.4 | 1.6 | 1.6 | 0.9 | 1.6 | 3.0 | 1.9 | 1.4 | 2.1 | 1.0 | 1.6 | 3.2 | 3.3 | 4.1 | 3.7 | 5.1 | 2.2 | 1.1 | 0.7 | 1.0 | 0.5 | 1.0 | 0.8 | 0.9 | 1.2 |
| | 9.5 | 12.2 | 4.4 | 3.6 | 4.9 | 4.2 | 3.3 | 3.5 | 3.7 | 3.7 | 3.7 | 1.8 | 2.1 | 3.9 | 3.7 | 4.5 | 7.4 | 17.4 | 3.3 | 1.9 | 1.6 | 2.5 | 1.7 | 2.1 | 0.8 | 1.6 | 1.7 |
| 4E | 8.0 | 9.8 | 1.0 | 2.1 | 1.9 | 1.3 | 0.9 | 2.4 | 1.5 | 1.2 | 1.8 | 1.6 | 2.7 | 1.9 | 3.0 | 2.4 | 3.7 | 6.0 | 2.4 | 1.8 | 1.1 | 1.4 | 0.4 | 0.7 | 1.1 | 0.[illegible] | 1.2 |
| | 9.5 | 12.2 | 3.3 | 4.2 | 5.3 | 3.6 | 2.7 | 3.6 | 3.4 | 3.6 | 3.3 | 2.2 | 2.7 | 2.9 | 2.8 | 3.4 | 6.2 | 17.3 | 3.1 | 2.7 | 1.3 | 1.9 | 1.9 | 1.7 | 1.0 | 1.7 | 2.2 |
| | | | | | | | | | | | | | 326 Degrees | | | | | | | | | | | | | | |
| 4D | 6.0 | 5.6 | 0.4 | 0.2 | 0.3 | 0.5 | 0.7 | 0.9 | 2.1 | 0.3 | 0.9 | 1.2 | 1.9 | 3.4 | 2.7 | 4.4 | 6.4 | 4.7 | 2.7 | 0.9 | 0.2 | 1.0 | 0.9 | 0.8 | 0.5 | 0.2 | 1.0 |
| | 7.0 | 8.0 | 0.8 | 1.0 | 0.7 | 1.0 | 1.0 | 1.5 | 1.9 | 0.6 | 1.6 | 2.6 | 2.8 | 4.0 | 4.4 | 6.9 | 9.4 | 10.5 | 5.4 | 2.1 | 1.6 | 0.8 | 1.7 | 0.8 | 2.3 | 0.7 | 2.5 |
| | 8.0 | 5.5 | 1.0 | 0.6 | 0.4 | 0.5 | 0.4 | 0.5 | 1.7 | 0.4 | 0.8 | 0.6 | 2.7 | 2.3 | 3.1 | 3.9 | 5.1 | 6.4 | 3.8 | 1.8 | 1.4 | 0.5 | 0.5 | 0.6 | 0.6 | 0.4 | 1.2 |
| | | 10.3 | 1.3 | 2.1 | 1.5 | 1.3 | 2.5 | 2.8 | 4.9 | 2.4 | 3.3 | 2.4 | 3.9 | 3.7 | 6.0 | 8.1 | 12.7 | 15.5 | 6.2 | 3.9 | 2.8 | 3.4 | 1.8 | 2.0 | 2.0 | 1.8 | 4.8 |
| | 8.5 | 10.7 | 2.6 | 2.5 | 2.3 | 1.7 | 3.4 | 4.2 | 5.0 | 2.0 | 3.5 | 2.7 | 4.3 | 4.3 | 7.4 | 9.8 | 13.3 | 13.6 | 5.5 | 3.9 | 2.1 | 5.0 | 3.0 | 3.0 | 3.4 | 2.2 | 4.4 |
| | 9.0 | 6.2 | 1.3 | 1.5 | 1.3 | 1.3 | 0.9 | 1.3 | 1.5 | 1.2 | 1.4 | 1.1 | 2.1 | 1.4 | 2.0 | 3.1 | 4.3 | 7.1 | 2.6 | 2.4 | 0.9 | 1.5 | 0.9 | 1.1 | 0.4 | 0.7 | 2.1 |
| | | 11.9 | 3.8 | 3.5 | 3.9 | 3.0 | 3.7 | 4.2 | 5.2 | 3.5 | 3.2 | 3.2 | 4.9 | 3.7 | 6.7 | 9.4 | 13.8 | 19.5 | 5.0 | 5.5 | 3.0 | 4.0 | 2.5 | 2.6 | 2.0 | 2.8 | 3.4 |
| | 10.0 | 13.7 | 4.7 | 6.6 | 5.0 | 4.7 | 4.6 | 5.5 | 4.6 | 6.0 | 4.6 | 6.2 | 6.4 | 5.6 | 8.1 | 9.8 | 16.4 | 23.3 | 8.0 | 7.2 | 5.2 | 6.5 | 2.5 | 4.6 | 2.5 | 3.3 | 5.1 |

Table 13

Comparison of Wave Heights for Existing Conditions (EC) and Fair-Weather Plans 1A, 2A, 3-3D, and 4-4C for Representative Test Waves from 279 deg, +2.6 ft swl, River Discharge 800 cfs

| | Wave Height, ft | | | | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Plan No. | Gage 1 | Gage 2 | Gage 3 | Gage 4 | Gage 5 | Gage 6 | Gage 7 | Gage 8 | Gage 9 | Gage 10 | Gage 11 | Gage 12 | Gage 13 | Gage 14 | Gage 15 | Gage 16 | Gage 17 | Gage 18 | Gage 19 | Gage 20 | Gage 21 | Gage 22 | Gage 23 | Gage 24 | Gage 25 |
| | | | | | | | | | | | | 9-sec, 8.6-ft Waves* | | | | | | | | | | | | | |
| EC | 3.2 | 2.5 | 2.0 | 1.4 | 1.3 | 1.2 | 1.3 | 2.4 | 1.4 | 1.1 | 1.9 | 1.8 | 2.3 | 5.5 | 5.6 | 10.5 | 2.0 | 3.4 | 2.3 | 2.5 | 2.0 | 1.4 | 1.4 | 1.2 | 2.3 |
| 1A | 3.1 | 2.9 | 2.4 | 1.9 | 1.1 | 1.7 | 1.7 | 1.8 | 1.2 | 1.8 | 2.2 | 1.7 | 1.1 | 5.1 | 4.5 | 10.4 | 1.5 | 5.9 | 2.8 | 5.1 | 2.2 | 2.7 | 1.6 | 1.8 | 1.9 |
| 2A | 2.7 | 2.0 | 3.1 | 1.7 | 1.4 | 1.6 | 1.7 | 2.0 | 1.4 | 1.4 | 2.3 | 1.7 | 2.9 | 3.5 | 4.6 | 7.9 | 1.8 | 4.7 | 2.1 | 3.5 | 1.4 | 2.1 | 1.6 | 1.4 | 1.6 |
| 3 | 2.0 | 1.8 | 1.5 | 1.6 | 0.9 | 1.3 | 1.7 | 2.3 | 1.8 | 1.4 | 2.3 | 1.6 | 2.4 | 1.9 | 5.2 | 9.7 | 2.3 | 4.8 | 3.0 | 4.1 | 2.0 | 1.6 | 1.4 | 2.0 | 2.0 |
| 3A | 2.1 | 1.7 | 2.2 | 1.6 | 1.2 | 1.0 | 2.7 | 2.0 | 1.3 | 1.4 | 3.2 | 1.6 | 3.1 | 2.7 | 5.9 | 8.4 | 2.3 | 4.5 | 2.3 | 4.8 | 2.3 | 2.1 | 1.8 | 2.5 | 1.6 |
| 3B | 2.6 | 1.9 | 2.1 | 1.8 | 1.3 | 1.4 | 2.6 | 3.0 | 1.7 | 1.3 | 2.1 | 1.4 | 3.3 | 3.0 | 4.8 | 7.7 | 2.8 | 4.1 | 2.0 | 4.5 | 2.2 | 2.1 | 1.9 | 1.5 | 2.9 |
| 3C | 2.0 | 2.5 | 1.6 | 1.5 | 1.1 | 2.1 | 1.9 | 2.3 | 1.3 | 1.5 | 1.7 | 2.1 | 2.0 | 4.4 | 2.5 | 5.8 | 3.3 | 2.0 | 1.1 | 3.0 | 2.4 | 2.0 | 1.8 | 1.8 | 1.4 |
| 3D | 2.6 | 2.4 | 1.8 | 1.3 | 1.2 | 2.1 | 1.5 | 2.2 | 1.3 | 1.1 | 1.5 | 2.0 | 1.6 | 4.1 | 3.1 | 6.4 | 2.8 | 2.8 | 1.5 | 3.4 | 2.2 | 2.3 | 1.7 | 1.7 | 1.6 |
| 4 | 3.3 | 2.0 | 2.3 | 1.5 | 0.9 | 1.2 | 1.0 | 2.1 | 1.4 | 1.0 | 1.4 | 1.0 | 1.5 | 2.5 | 3.5 | 6.3 | 1.3 | 2.4 | 1.4 | 2.6 | 1.3 | 1.5 | 1.5 | 1.0 | 1.4 |
| 4A | 2.5 | 2.0 | 2.1 | 1.3 | 1.3 | 1.2 | 2.0 | 2.3 | 1.8 | 1.1 | 1.7 | 1.9 | 1.6 | 2.3 | 3.7 | 7.6 | 1.3 | 2.6 | 1.6 | 2.2 | 0.8 | 0.9 | 0.9 | 1.3 | 1.1 |
| 4B | 2.2 | 2.5 | 2.2 | 1.5 | 1.1 | 1.2 | 2.1 | 2.9 | 2.1 | 1.5 | 2.5 | 2.0 | 2.4 | 3.2 | 3.6 | 6.0 | 2.7 | 3.2 | 1.8 | 4.1 | 2.1 | 1.5 | 1.3 | 1.0 | 1.5 |
| 4C | 1.6 | 1.2 | 1.9 | 1.5 | 0.8 | 1.1 | 1.0 | 1.9 | 1.4 | 1.1 | 1.8 | 1.3 | 1.3 | 2.3 | 3.2 | 7.4 | 1.8 | 3.1 | 1.7 | 2.6 | 1.0 | 1.5 | 1.3 | 1.0 | 1.0 |
| | | | | | | | | | | | | 10-sec, 9.2-ft Waves** | | | | | | | | | | | | | |
| EC | 2.6 | 2.7 | 3.2 | 2.3 | 1.7 | 2.0 | 1.9 | 2.1 | 2.2 | 1.9 | 2.0 | 2.1 | 2.9 | 7.8 | 7.1 | 11.9 | 4.6 | 4.0 | 2.6 | 4.2 | 1.5 | 3.2 | 1.2 | 2.4 | 2.4 |
| 1A | 3.0 | 2.8 | 3.4 | 3.2 | 2.6 | 2.4 | 2.0 | 2.5 | 2.4 | 4.1 | 4.8 | 4.2 | 4.3 | 5.8 | 7.2 | 9.9 | 2.5 | 5.9 | 4.6 | 5.8 | 2.2 | 5.5 | 2.5 | 4.0 | 4.1 |
| 2A | 2.9 | 1.9 | 3.0 | 2.6 | 2.5 | 2.2 | 2.7 | 3.0 | 2.3 | 3.2 | 3.8 | 4.4 | 3.0 | 4.5 | 6.4 | 8.6 | 2.5 | 3.7 | 2.5 | 3.6 | 2.0 | 4.3 | 1.9 | 4.4 | 4.6 |
| 3 | 2.4 | 1.9 | 3.5 | 1.7 | 1.3 | 2.3 | 2.3 | 1.8 | 2.2 | 3.2 | 2.9 | 2.2 | 4.5 | 4.1 | 5.8 | 7.0 | 4.2 | 5.7 | 3.7 | 5.3 | 2.0 | 3.1 | 1.2 | 3.5 | 2.7 |
| 3A | 2.6 | 2.3 | 3.3 | 2.6 | 2.5 | 2.3 | 2.9 | 2.5 | 2.3 | 2.4 | 3.4 | 3.4 | 4.7 | 4.1 | 7.0 | 7.9 | 3.6 | 5.0 | 3.6 | 6.2 | 2.7 | 3.9 | 2.0 | 3.9 | 3.6 |
| 3B | 3.0 | 2.7 | 3.2 | 3.0 | 3.0 | 2.6 | 2.1 | 3.2 | 3.5 | 2.2 | 3.1 | 3.1 | 4.0 | 4.4 | 4.5 | 5.7 | 4.5 | 3.6 | 2.8 | 4.2 | 3.2 | 5.2 | 2.0 | 3.8 | 2.8 |
| 3C | 3.2 | 3.1 | 3.3 | 3.2 | 2.8 | 3.1 | 3.0 | 2.2 | 4.0 | 2.1 | 3.9 | 3.0 | 4.9 | 3.1 | 7.0 | 6.2 | 3.5 | 4.0 | 2.6 | 4.1 | 2.3 | 4.5 | 1.7 | 4.3 | 2.2 |
| 3D | 2.2 | 2.9 | 2.2 | 2.4 | 2.4 | 2.7 | 1.8 | 2.4 | 2.6 | 1.7 | 2.8 | 2.9 | 3.5 | 4.8 | 3.5 | 4.1 | 4.3 | 2.2 | 1.5 | 3.1 | 2.2 | 3.7 | 1.6 | 3.5 | 2.2 |
| 4 | 2.4 | 2.4 | 2.0 | 2.2 | 2.3 | 1.9 | 2.3 | 2.1 | 2.2 | 1.5 | 1.7 | 1.6 | 1.9 | 2.8 | 4.1 | 5.4 | 2.7 | 3.1 | 2.5 | 2.9 | 1.3 | 3.3 | 1.4 | 2.9 | 3.0 |
| 4A | 2.7 | 1.7 | 2.9 | 2.2 | 2.1 | 2.1 | 2.0 | 2.2 | 2.1 | 1.6 | 1.9 | 2.0 | 1.7 | 3.5 | 3.7 | 5.8 | 3.3 | 3.2 | 3.2 | 2.9 | 1.3 | 3.3 | 1.7 | 2.2 | 3.0 |
| 4B | 2.8 | 2.5 | 2.1 | 2.0 | 3.2 | 2.6 | 2.0 | 1.9 | 2.5 | 1.6 | 2.1 | 2.7 | 4.0 | 5.6 | 6.6 | 8.3 | 4.5 | 4.5 | 3.3 | 5.3 | 2.7 | 4.7 | 1.6 | 5.2 | 3.7 |
| 4C | 2.6 | 2.2 | 3.3 | 2.3 | 1.4 | 2.2 | 2.2 | 2.3 | 2.0 | 2.5 | 2.4 | 2.1 | 1.5 | 3.8 | 5.0 | 7.2 | 2.9 | 4.0 | 2.9 | 3.7 | 1.4 | 2.8 | 1.1 | 2.6 | 2.2 |

* 20-year recurrence interval.
** 100-year recurrence interval.

Table 14

Comparison of Wave Heights for Existing Conditions (EC) and Fair-Weather Plans 1A, 2A, 4D, 4E for Test Waves from 17 deg, +2.6 ft swl, River Discharge 800 cfs

| Plan No. | Wave Height, ft Gage 1 | Gage 2 | Gage 3 | Gage 4 | Gage 5 | Gage 6 | Gage 7 | Gage 8 | Gage 9 | Gage 10 | Gage 11 | Gage 12 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | 8-sec, 9.8-ft Waves* | | | | | | | |
| EC | 1.8 | 1.1 | 1.4 | 1.0 | 1.6 | 2.8 | 2.9 | 1.1 | 0.9 | 1.7 | 3.0 | 3.6 |
| 1A | 1.2 | 1.3 | 1.4 | 0.9 | 1.9 | 3.8 | 2.1 | 1.4 | 2.2 | 1.0 | 2.1 | 3.3 |
| 2A | 2.0 | 3.1 | 2.2 | 1.5 | 2.0 | 3.0 | 2.9 | 1.0 | 3.0 | 2.0 | 1.6 | 3.6 |
| 4D | 1.4 | 1.6 | 1.6 | 0.9 | 1.6 | 3.0 | 1.9 | 1.4 | 2.1 | 1.0 | 1.6 | 3.2 |
| 4E | 1.0 | 2.1 | 1.9 | 1.3 | 0.9 | 2.4 | 1.5 | 1.2 | 1.8 | 1.6 | 2.7 | 1.9 |
| | | | | | 9.5-sec, 12.2-ft Waves** | | | | | | | |
| EC | 4.2 | 3.8 | 3.0 | 3.2 | 2.1 | 2.5 | 4.2 | 2.1 | 2.5 | 2.6 | 3.5 | 4.5 |
| 1A | 4.5 | 5.0 | 4.6 | 3.6 | 3.6 | 5.1 | 5.0 | 3.8 | 3.6 | 2.7 | 4.7 | 6.4 |
| 2A | 5.0 | 4.5 | 3.8 | 3.8 | 3.5 | 4.2 | 4.2 | 3.1 | 3.0 | 1.9 | 2.9 | 4.0 |
| 4D | 4.4 | 3.6 | 4.9 | 4.2 | 3.3 | 3.5 | 3.7 | 3.7 | 3.7 | 1.8 | 2.1 | 3.9 |
| 4E | 3.3 | 4.2 | 5.3 | 3.6 | 2.7 | 3.6 | 3.4 | 3.6 | 3.3 | 2.2 | 2.7 | 2.9 |

(Continued)

* 20-year recurrence interval.
** 100-year recurrence interval.

Table 14 (Concluded)

| Plan No. | Wave Height, ft | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Gage 13 | Gage 14 | Gage 15 | Gage 16 | Gage 17 | Gage 18 | Gage 19 | Gage 20 | Gage 21 | Gage 22 | Gage 23 | Gage 24 | Gage 25 |
| | | | | | | 8-sec, 9.8-ft Waves* | | | | | | | |
| EC | 4.1 | 6.0 | 7.1 | 7.2 | 1.9 | 1.4 | 0.5 | 0.7 | 0.5 | 0.7 | 0.8 | 0.7 | 1.1 |
| 1A | 4.4 | 4.0 | 4.8 | 8.0 | 1.2 | 1.5 | 0.9 | 1.4 | 0.5 | 1.3 | 0.9 | 0.6 | 1.0 |
| 2A | 2.7 | 2.6 | 3.9 | 7.0 | 2.1 | 1.3 | 0.9 | 1.3 | 0.7 | 1.1 | 1.0 | 0.7 | 1.8 |
| 4D | 3.3 | 4.1 | 3.7 | 5.1 | 2.2 | 1.1 | 0.7 | 1.0 | 0.5 | 1.0 | 0.8 | 0.9 | 1.2 |
| 4E | 3.0 | 2.4 | 3.7 | 6.0 | 2.4 | 1.8 | 1.1 | 1.4 | 0.4 | 0.7 | 1.1 | 0.8 | 1.2 |
| | | | | | | 9.5-sec, 12.2-ft Waves** | | | | | | | |
| EC | 5.5 | 6.2 | 10.4 | 21.5 | 3.4 | 2.3 | 2.0 | 2.3 | 1.5 | 2.1 | 0.7 | 1.7 | 1.8 |
| 1A | 7.2 | 7.4 | 12.1 | 22.4 | 5.7 | 2.8 | 2.3 | 3.5 | 1.4 | 1.9 | 0.8 | 1.4 | 2.1 |
| 2A | 4.6 | 4.9 | 9.4 | 19.6 | 4.6 | 2.9 | 2.1 | 3.3 | 1.4 | 1.9 | 0.9 | 1.8 | 2.3 |
| 4D | 3.7 | 4.5 | 7.4 | 17.4 | 3.3 | 1.9 | 1.6 | 2.5 | 1.7 | 2.1 | 0.8 | 1.6 | 1.7 |
| 4E | 2.8 | 3.4 | 6.2 | 17.3 | 3.1 | 2.7 | 1.3 | 1.9 | 1.9 | 1.7 | 1.0 | 1.7 | 2.2 |

* 20-year recurrence interval.
** 100-year recurrence interval.

Table 15

Comparison of Wave Heights for Existing Conditions (EC) and Fair-Weather Plans 1A, 2A, 4D for Test Waves from 326 deg, +2.6 ft swl, River Discharge 800 cfs

| Plan No. | Wave Height, ft | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Gage 1 | Gage 2 | Gage 3 | Gage 4 | Gage 5 | Gage 6 | Gage 7 | Gage 8 | Gage 9 | Gage 10 | Gage 11 | Gage 12 |
| | | | | | 8-sec, 9.8-ft Waves* | | | | | | | |
| EC | 1.8 | 1.1 | 1.4 | 1.0 | 1.6 | 2.8 | 2.9 | 1.1 | 0.9 | 1.7 | 3.0 | 3.6 |
| 1A | 1.2 | 1.3 | 1.4 | 0.9 | 1.9 | 3.8 | 2.1 | 1.4 | 2.2 | 1.0 | 2.1 | 3.3 |
| 2A | 2.0 | 3.1 | 2.2 | 1.5 | 2.0 | 3.0 | 2.9 | 1.0 | 3.0 | 2.0 | 1.6 | 3.6 |
| 4D | 1.4 | 1.6 | 1.6 | 0.9 | 1.6 | 3.0 | 1.9 | 1.4 | 2.1 | 1.0 | 1.6 | 3.2 |
| 4E | 1.0 | 2.1 | 1.9 | 1.3 | 0.9 | 2.4 | 1.5 | 1.2 | 1.8 | 1.6 | 2.7 | 1.9 |
| | | | | | 9.5-sec, 12.2-ft Waves** | | | | | | | |
| EC | 4.2 | 3.8 | 3.0 | 3.2 | 2.1 | 2.5 | 4.2 | 2.1 | 2.5 | 2.6 | 3.5 | 4.5 |
| 1A | 4.5 | 5.0 | 4.6 | 3.6 | 3.6 | 5.1 | 5.0 | 3.8 | 3.6 | 2.7 | 4.7 | 6.4 |
| 2A | 5.0 | 4.5 | 3.8 | 3.8 | 3.5 | 4.2 | 4.2 | 3.1 | 3.0 | 1.9 | 2.9 | 4.0 |
| 4D | 4.4 | 3.6 | 4.9 | 4.2 | 3.3 | 3.5 | 3.7 | 3.7 | 3.7 | 1.8 | 2.1 | 3.9 |
| 4E | 3.3 | 4.2 | 5.3 | 3.6 | 2.7 | 3.6 | 3.4 | 3.6 | 3.3 | 2.2 | 2.7 | 2.9 |

(Continued)

* 20-year recurrence interval.
** 100-year recurrence interval.

Table 15 (Concluded)

| Plan No. | Wave Height, ft | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Gage 13 | Gage 14 | Gage 15 | Gage 16 | Gage 17 | Gage 18 | Gage 19 | Gage 20 | Gage 21 | Gage 22 | Gage 23 | Gage 24 | Gage 25 |
| 8-sec, 9.8-ft Waves* | | | | | | | | | | | | | |
| EC | 4.1 | 6.0 | 7.1 | 7.2 | 1.9 | 1.4 | 0.5 | 0.7 | 0.5 | 0.7 | 0.8 | 0.7 | 1.1 |
| 1A | 4.4 | 4.0 | 4.8 | 8.0 | 1.2 | 1.5 | 0.9 | 1.4 | 0.5 | 1.3 | 0.9 | 0.6 | 1.0 |
| 2A | 2.7 | 2.6 | 3.9 | 7.0 | 2.1 | 1.3 | 0.9 | 1.3 | 0.7 | 1.1 | 1.0 | 0.7 | 1.8 |
| 4D | 3.3 | 4.1 | 3.7 | 5.1 | 2.2 | 1.1 | 0.7 | 1.0 | 0.5 | 1.0 | 0.8 | 0.9 | 1.2 |
| 4E | 3.0 | 2.4 | 3.7 | 6.0 | 2.4 | 1.8 | 1.1 | 1.4 | 0.4 | 0.7 | 1.1 | 0.8 | 1.2 |
| 9.5-sec, 12.2-ft Waves** | | | | | | | | | | | | | |
| EC | 5.5 | 6.2 | 10.4 | 21.5 | 3.4 | 2.3 | 2.0 | 2.3 | 1.5 | 2.1 | 0.7 | 1.7 | 1.8 |
| 1A | 7.2 | 7.4 | 12.1 | 22.4 | 5.7 | 2.8 | 2.3 | 3.5 | 1.4 | 1.9 | 0.8 | 1.4 | 2.1 |
| 2A | 4.6 | 4.9 | 9.4 | 19.6 | 4.6 | 2.9 | 2.1 | 3.3 | 1.4 | 1.9 | 0.9 | 1.8 | 2.3 |
| 4D | 3.7 | 4.5 | 7.4 | 17.4 | 3.3 | 1.9 | 1.6 | 2.5 | 1.7 | 2.1 | 0.8 | 1.6 | 1.7 |
| 4E | 2.8 | 3.4 | 6.2 | 17.3 | 3.1 | 2.7 | 1.3 | 1.9 | 1.9 | 1.7 | 1.0 | 1.7 | 2.2 |

* 20-year recurrence interval.
** 100-year recurrence interval.

Table 16

Wave Heights for Fair-Weather Plan 4D,

0.0-ft swl, River Discharge 800 cfs

| Test Wave | | | Wave Height, ft | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Direction deg | Period sec | Height ft | Gage 1 | Gage 2 | Gage 3 | Gage 4 | Gage 5 | Gage 6 | Gage 7 | Gage 8 | Gage 9 | Gage 10 | Gage 11 | Gage 12 |
| 279 | 6.0 | 3.9 | 0.1 | <0.1 | 0.2 | 0.2 | <0.1 | 0.1 | <0.1 | 0.1 | <0.1 | 0.2 | 0.1 | 0.2 |
| | 7.0 | 5.5 | 0.3 | 0.2 | <0.1 | 0.2 | 0.3 | 0.4 | 0.2 | <0.1 | 0.3 | 0.3 | 0.1 | 0.3 |
| | 8.0 | 6.6 | 0.6 | 0.6 | 0.5 | 0.4 | 0.4 | 0.5 | 0.6 | 0.5 | 0.4 | 0.5 | 0.8 | 0.5 |
| | 9.0 | 4.3 | 0.2 | 0.6 | 0.4 | 0.3 | 0.6 | 0.4 | 0.5 | 0.5 | 0.4 | 0.3 | 0.3 | 0.4 |
| | | 8.1 | 0.7 | 0.9 | 0.8 | 0.6 | 0.7 | 0.5 | 0.9 | 1.0 | 0.9 | 0.5 | 0.6 | 0.8 |
| | | 8.6 | 0.9 | 1.3 | 1.1 | 0.7 | 1.2 | 0.8 | 1.4 | 1.4 | 1.1 | 0.6 | 0.6 | 0.8 |
| | 10.0 | 9.2 | 2.0 | 2.1 | 2.5 | 2.0 | 0.9 | 1.1 | 1.4 | 1.4 | 1.3 | 1.3 | 2.5 | 1.9 |
| 326 | 6.0 | 5.6 | 0.3 | 0.2 | 0.2 | 0.5 | 0.6 | 0.3 | 1.9 | 0.4 | 0.6 | 2.2 | 1.0 | 3.3 |
| | 7.0 | 8.0 | 0.4 | 0.6 | 0.5 | 0.7 | 0.4 | 1.4 | 2.8 | 0.6 | 0.4 | 2.3 | 1.5 | 3.1 |
| | 8.0 | 5.5 | 0.2 | 0.3 | 0.2 | 0.1 | 0.4 | 0.5 | 1.5 | 0.4 | 0.6 | 1.3 | 1.2 | 1.0 |
| | | 10.3 | 1.8 | 1.9 | 1.5 | 1.1 | 2.1 | 2.1 | 3.9 | 1.4 | 1.5 | 3.4 | 3.6 | 4.6 |
| | 8.5 | 10.7 | 1.7 | 2.0 | 1.5 | 1.1 | 2.2 | 2.4 | 4.5 | 1.7 | 2.0 | 2.2 | 4.5 | 4.5 |
| | 9.0 | 6.2 | 1.1 | 1.4 | 0.7 | 0.5 | 0.5 | 0.8 | 1.6 | 1.1 | 0.6 | 0.9 | 2.2 | 2.5 |
| | | 11.9 | 2.4 | 2.0 | 2.3 | 1.7 | 2.2 | 3.1 | 4.9 | 2.4 | 2.4 | 2.6 | 4.9 | 5.0 |
| | 10.0 | 13.7 | 2.6 | 2.7 | 2.9 | 2.9 | 2.5 | 2.9 | 4.2 | 2.4 | 2.3 | 4.9 | 4.7 | 4.6 |
| 17 | 6.0 | 4.7 | 0.1 | 0.2 | 0.2 | 0.3 | 0.3 | 0.4 | 0.8 | 0.3 | 0.2 | 0.4 | 0.2 | 0.1 |
| | 7.0 | 7.3 | 0.3 | 0.5 | 0.6 | 0.4 | 0.4 | 1.0 | 1.7 | 0.4 | 0.3 | 0.7 | 0.2 | 1.4 |
| | 8.0 | 5.1 | 0.4 | 0.3 | 0.2 | 0.3 | 0.2 | 0.8 | 2.0 | 0.2 | 0.3 | 0.4 | 0.4 | 1.1 |
| | | 8.9 | 0.6 | 0.5 | 0.4 | 0.3 | 0.5 | 1.0 | 2.6 | 0.3 | 0.5 | 1.2 | 1.2 | 1.9 |
| | | 9.8 | 0.8 | 0.6 | 0.5 | 0.5 | 0.5 | 1.2 | 2.7 | 0.4 | 0.7 | 1.2 | 1.2 | 2.3 |
| | 9.5 | 12.2 | 1.5 | 1.6 | 1.4 | 1.3 | 1.6 | 2.1 | 3.9 | 0.9 | 1.7 | 1.2 | 2.7 | 3.6 |

(Continued)

Table 16 (Concluded)

| Test Wave | | | Wave Height, ft | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Direction deg | Period sec | Height ft | Gage 13 | Gage 14 | Gage 15 | Gage 16 | Gage 17 | Gage 18 | Gage 19 | Gage 20 | Gage 21 | Gage 22 | Gage 23 | Gage 24 | Gage 25 |
| 279 | 6.0 | 3.9 | 0.3 | 0.3 | 0.7 | 0.8 | 0.2 | 0.4 | 0.2 | 0.1 | 0.4 | <0.1 | <0.1 | <0.1 | 0.1 |
| | 7.0 | 5.5 | 0.5 | 0.5 | 1.6 | 2.1 | 0.2 | 0.5 | 0.4 | 0.2 | 0.5 | 0.2 | 0.5 | 0.1 | 0.3 |
| | 8.0 | 6.6 | 0.4 | 0.8 | 1.5 | 5.2 | 1.0 | 0.9 | 0.9 | 0.7 | 0.3 | 0.4 | 0.3 | 0.5 | 0.6 |
| | 9.0 | 4.3 | 0.3 | 0.5 | 0.9 | 3.8 | 1.5 | 1.2 | 0.8 | 0.8 | 0.7 | 0.4 | 0.3 | 0.5 | 0.2 |
| | | 8.1 | 0.9 | 1.6 | 2.1 | 7.1 | 2.8 | 2.3 | 1.6 | 1.7 | 1.4 | 1.1 | 0.8 | 1.2 | 0.8 |
| | | 8.6 | 1.1 | 1.5 | 1.9 | 8.3 | 2.2 | 2.3 | 1.7 | 2.1 | 1.1 | 1.2 | 0.8 | 1.1 | 0.8 |
| | 10.0 | 9.2 | 1.5 | 3.1 | 5.2 | 7.5 | 2.9 | 2.7 | 2.6 | 3.4 | 1.1 | 2.0 | 0.9 | 2.5 | 1.1 |
| 326 | 6.0 | 5.6 | 3.6 | 5.0 | 7.1 | 3.8 | 3.7 | 1.2 | 0.6 | 0.2 | 0.6 | 0.3 | 0.1 | 0.2 | 0.5 |
| | 7.0 | 8.0 | 3.8 | 5.5 | 8.6 | 9.5 | 5.2 | 1.7 | 1.6 | 0.6 | 1.4 | 0.4 | 0.5 | 0.6 | 1.7 |
| | 8.0 | 5.5 | 2.3 | 3.2 | 4.3 | 5.7 | 2.3 | 1.0 | 0.9 | 0.9 | 0.2 | 0.4 | 0.3 | 0.5 | 1.1 |
| | | 10.3 | 5.9 | 8.0 | 11.8 | 12.4 | 5.1 | 2.7 | 2.2 | 1.5 | 0.8 | 1.0 | 1.3 | 0.9 | 3.1 |
| | 8.5 | 10.7 | 6.3 | 8.1 | 12.1 | 13.8 | 6.0 | 4.0 | 2.8 | 2.6 | 1.8 | 1.4 | 1.5 | 1.4 | 3.1 |
| | 9.0 | 6.2 | 2.2 | 3.5 | 4.9 | 5.7 | 3.7 | 2.0 | 1.4 | 1.7 | 1.1 | 0.6 | 0.7 | 1.1 | 1.2 |
| | | 11.9 | 6.9 | 9.0 | 12.5 | 16.0 | 5.7 | 4.4 | 2.6 | 3.7 | 2.0 | 1.7 | 1.4 | 1.2 | 2.8 |
| | 10.0 | 13.7 | 7.6 | 9.7 | 11.3 | 19.2 | 6.2 | 4.7 | 3.2 | 4.4 | 1.8 | 3.0 | 1.3 | 2.4 | 3.0 |
| 17 | 6.0 | 4.7 | 0.5 | 0.9 | 0.6 | 3.3 | 0.2 | 0.2 | <0.1 | <0.1 | 0.1 | <0.1 | <0.1 | <0.1 | <0.1 |
| | 7.0 | 7.3 | 1.8 | 1.6 | 1.3 | 6.5 | 1.0 | 0.2 | 0.2 | 0.2 | 0.2 | 0.1 | 0.2 | 0.2 | 0.2 |
| | 8.0 | 5.1 | 1.4 | 1.1 | 0.8 | 3.1 | 0.2 | 0.4 | 0.4 | 0.2 | 0.2 | 0.2 | 0.2 | 0.1 | 0.3 |
| | | 8.9 | 2.1 | 1.8 | 2.0 | 4.9 | 1.5 | 0.6 | 0.5 | 0.5 | 0.2 | 0.3 | 0.2 | 0.2 | 0.3 |
| | | 9.8 | 2.7 | 2.1 | 2.4 | 6.1 | 1.1 | 0.6 | 0.5 | 0.4 | 0.2 | 0.4 | 0.2 | 0.2 | 0.4 |
| | 9.5 | 12.2 | 4.5 | 5.5 | 7.3 | 15.5 | 1.9 | 1.6 | 0.9 | 1.5 | 1.3 | 1.1 | 0.5 | 0.7 | 1.4 |

Table 17

Wave Heights for Fair-Weather Plan 4D,

0.0-ft swl, River Discharge 8,000 cfs

| Test Wave | | | Wave Height, ft | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Direction deg | Period sec | Height ft | Gage 1 | Gage 2 | Gage 3 | Gage 4 | Gage 5 | Gage 6 | Gage 7 | Gage 8 | Gage 9 | Gage 10 | Gage 11 | Gage 12 |
| 279 | 6.0 | 3.9 | 0.1 | <0.1 | 0.2 | 0.2 | <0.1 | 0.1 | 0.1 | 0.1 | <0.1 | 0.2 | <0.1 | <0.1 |
| | 7.0 | 5.5 | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 | 0.3 | 0.4 | 0.1 | 0.2 | 0.2 | 0.1 | 0.1 |
| | 8.0 | 6.6 | 0.6 | 0.5 | 0.4 | 0.4 | 0.4 | 0.6 | 0.6 | 0.5 | 0.3 | 0.6 | 0.9 | 0.9 |
| | 9.0 | 4.3 | 0.2 | 0.5 | 0.3 | 0.2 | 0.6 | 0.4 | 0.6 | 0.5 | 0.4 | 0.3 | 0.3 | 0.3 |
| | | 8.1 | 0.7 | 1.1 | 0.8 | 0.6 | 0.8 | 0.5 | 0.9 | 1.2 | 0.9 | 0.3 | 0.5 | 0.8 |
| | | 8.6 | 1.0 | 1.2 | 1.2 | 0.7 | 1.1 | 0.9 | 1.4 | 1.1 | 1.0 | 0.5 | 0.7 | 0.9 |
| | 10.0 | 9.2 | 2.2 | 1.9 | 2.5 | 1.9 | 0.8 | 1.2 | 1.5 | 1.5 | 1.4 | 1.5 | 2.2 | 1.7 |
| 326 | 6.0 | 5.6 | 0.5 | 0.2 | 0.2 | 0.3 | 0.3 | 0.5 | 0.7 | 0.2 | 0.2 | 1.4 | 1.6 | 3.5 |
| | 7.0 | 8.0 | 0.3 | 0.4 | 0.5 | 0.6 | 0.6 | 1.0 | 1.5 | 0.4 | 0.6 | 2.3 | 2.1 | 3.3 |
| | 8.0 | 5.5 | 0.3 | 0.4 | 0.5 | 0.2 | 0.4 | 0.8 | 1.6 | 0.3 | 0.6 | 1.5 | 1.8 | 1.4 |
| | | 10.3 | 1.9 | 1.2 | 1.2 | 0.8 | 1.9 | 2.2 | 4.0 | 1.2 | 1.2 | 3.5 | 3.6 | 4.3 |
| | 8.5 | 10.7 | 1.8 | 2.1 | 1.5 | 1.1 | 1.8 | 2.7 | 4.5 | 1.7 | 2.2 | 2.1 | 4.1 | 4.4 |
| | 9.0 | 6.2 | 0.8 | 1.4 | 0.7 | 0.7 | 0.5 | 0.6 | 1.6 | 0.7 | 0.6 | 0.8 | 2.0 | 2.1 |
| | | 11.9 | 2.2 | 2.4 | 2.5 | 1.6 | 2.3 | 3.2 | 4.8 | 2.4 | 2.5 | 2.6 | 4.9 | 4.6 |
| | 10.0 | 13.7 | 3.0 | 2.7 | 2.6 | 3.1 | 2.7 | 3.7 | 4.8 | 2.3 | 3.1 | 5.3 | 5.6 | 5.2 |
| 17 | 6.0 | 4.7 | 0.1 | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 | 0.6 | 0.2 | 0.2 | <0.1 | 0.4 | 0.6 |
| | 7.0 | 7.3 | 0.4 | 0.4 | 0.5 | 0.4 | 0.2 | 0.8 | 2.1 | 0.4 | 0.3 | 0.6 | 0.4 | 0.8 |
| | 8.0 | 5.1 | 0.4 | 0.3 | 0.2 | 0.3 | 0.2 | 0.8 | 2.0 | 0.2 | 0.3 | 0.4 | 0.4 | 1.1 |
| | | 8.9 | 0.5 | 0.4 | 0.4 | 0.3 | 0.4 | 1.0 | 2.6 | 0.3 | 0.6 | 1.4 | 0.7 | 2.5 |
| | | 9.8 | 0.7 | 0.5 | 0.5 | 0.5 | 0.5 | 1.3 | 2.9 | 0.4 | 0.7 | 1.6 | 0.8 | 2.9 |
| | 9.5 | 12.2 | 1.8 | 1.7 | 1.7 | 1.5 | 1.9 | 1.7 | 4.8 | 1.3 | 1.9 | 1.4 | 2.7 | 3.8 |

(Continued)

Table 17 (Concluded)

| Test Wave | | | Wave Height, ft | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Direction deg | Period sec | Height ft | Gage 13 | Gage 14 | Gage 15 | Gage 16 | Gage 17 | Gage 18 | Gage 19 | Gage 20 | Gage 21 | Gage 22 | Gage 23 | Gage 24 | Gage 25 |
| 279 | 6.0 | 3.9 | 0.2 | 0.3 | 0.6 | 0.8 | 0.1 | 0.4 | 0.2 | 0.2 | 0.4 | <0.1 | <0.1 | <0.1 | 0.1 |
| | 7.0 | 5.5 | 0.4 | 0.3 | 1.2 | 1.7 | 0.4 | 0.5 | 0.4 | 0.1 | 0.4 | 0.2 | 0.3 | <0.1 | 0.1 |
| | 8.0 | 6.6 | 0.6 | 1.0 | 1.8 | 5.0 | 1.0 | 0.9 | 0.9 | 0.6 | 0.3 | 0.5 | 0.3 | 0.4 | 0.5 |
| | 9.0 | 4.3 | 0.3 | 0.3 | 0.5 | 3.6 | 1.3 | 1.0 | 0.6 | 0.6 | 0.7 | 0.4 | 0.3 | 0.3 | 0.2 |
| | | 8.1 | 0.7 | 1.5 | 1.8 | 7.4 | 2.6 | 1.9 | 1.5 | 1.4 | 1.2 | 1.0 | 0.6 | 1.0 | 0.7 |
| | | 8.6 | 0.8 | 1.4 | 1.8 | 8.6 | 2.2 | 2.1 | 1.7 | 1.9 | 1.1 | 1.1 | 0.8 | 1.1 | 0.7 |
| | 10.0 | 9.2 | 1.6 | 3.0 | 4.8 | 7.8 | 3.1 | 2.4 | 2.3 | 3.0 | 1.2 | 1.8 | 0.8 | 1.8 | 1.3 |
| 326 | 6.0 | 5.6 | 3.1 | 4.0 | 5.7 | 3.4 | 3.3 | 1.2 | 0.4 | 0.1 | 0.2 | 0.4 | 0.2 | 0.2 | 0.5 |
| | 7.0 | 8.0 | 4.1 | 5.3 | 8.6 | 10.0 | 5.2 | 2.0 | 1.5 | 0.7 | 0.9 | 0.5 | 1.0 | 0.5 | 1.0 |
| | 8.0 | 5.5 | 2.7 | 3.5 | 4.9 | 6.1 | 2.6 | 1.1 | 0.8 | 1.0 | 0.2 | 0.6 | 0.3 | 0.6 | 1.0 |
| | | 10.3 | 5.9 | 8.1 | 11.6 | 12.6 | 5.2 | 2.7 | 2.1 | 1.3 | 0.8 | 0.8 | 1.3 | 0.9 | 3.2 |
| | 8.5 | 10.7 | 7.1 | 8.5 | 11.9 | 15.5 | 6.8 | 4.3 | 2.7 | 2.7 | 2.1 | 1.6 | 1.7 | 1.6 | 2.8 |
| | 9.0 | 6.2 | 2.3 | 3.3 | 4.5 | 5.3 | 3.7 | 1.8 | 1.3 | 1.5 | 0.9 | 0.6 | 0.5 | 0.9 | 1.0 |
| | | 11.9 | 6.9 | 9.4 | 13.5 | 19.0 | 6.1 | 4.4 | 2.5 | 3.6 | 2.1 | 1.8 | 1.5 | 1.3 | 3.3 |
| | 10.0 | 13.7 | 8.3 | 11.1 | 13.6 | 20.1 | 5.8 | 3.8 | 2.7 | 3.9 | 1.9 | 2.1 | 1.3 | 1.9 | 2.6 |
| 17 | 6.0 | 4.7 | 0.4 | 0.7 | 0.6 | 2.4 | 0.1 | 0.1 | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 |
| | 7.0 | 7.3 | 1.4 | 1.9 | 1.4 | 6.3 | 0.5 | 0.3 | 0.1 | 0.1 | 0.3 | 0.1 | 0.3 | 0.2 | 0.4 |
| | 8.0 | 5.1 | 1.4 | 1.1 | 0.8 | 3.1 | 0.2 | 0.4 | 0.4 | 0.2 | 0.2 | 0.2 | 0.2 | 0.1 | 0.3 |
| | | 8.9 | 2.2 | 2.1 | 2.4 | 4.9 | 1.4 | 0.6 | 0.5 | 0.4 | 0.2 | 0.5 | 0.2 | 0.2 | 0.3 |
| | | 9.8 | 2.8 | 2.9 | 2.8 | 5.8 | 1.6 | 0.6 | 0.4 | 0.4 | 0.3 | 0.5 | 0.3 | 0.3 | 0.3 |
| | 9.5 | 12.2 | 5.0 | 5.3 | 7.8 | 13.5 | 2.0 | 1.4 | 0.9 | 1.4 | 1.0 | 1.1 | 0.4 | 0.6 | 1.3 |

Table 18

Wave Heights for Fair-Weather Plan 4D,

+2.6 ft swl, River Discharge 800 cfs

| Test Wave | | | Wave Height, ft | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Direction deg | Period sec | Height ft | Gage 1 | Gage 2 | Gage 3 | Gage 4 | Gage 5 | Gage 6 | Gage 7 | Gage 8 | Gage 9 | Gage 10 | Gage 11 | Gage 12 |
| 279 | 6.0 | 3.9 | 0.4 | 0.2 | <0.1 | 0.3 | 0.2 | <0.1 | 0.3 | 0.3 | 0.2 | 0.3 | 0.1 | <0.1 |
| | 7.0 | 5.5 | 0.2 | 0.3 | 0.5 | 0.5 | 0.4 | 0.2 | 0.5 | 0.6 | 0.5 | <0.1 | 0.3 | 0.3 |
| | 8.0 | 6.6 | 1.0 | 0.7 | 0.7 | 0.8 | 0.9 | 0.5 | 0.4 | 0.8 | 0.8 | 0.2 | 0.6 | 0.6 |
| | 9.0 | 4.3 | 0.4 | 0.3 | 1.1 | 0.5 | 0.5 | 0.5 | 0.7 | 0.9 | 0.3 | 0.2 | 0.3 | 0.4 |
| | | 8.1 | 1.5 | 2.0 | 1.6 | 1.5 | 1.0 | 1.2 | 0.9 | 2.3 | 1.2 | 1.3 | 0.8 | 1.4 |
| | | 8.6 | 1.9 | 2.4 | 2.5 | 1.9 | 1.3 | 1.6 | 1.5 | 2.7 | 1.2 | 1.5 | 1.1 | 1.6 |
| | 10.0 | 9.2 | 3.3 | 2.5 | 3.6 | 2.3 | 2.2 | 2.3 | 1.8 | 2.2 | 3.2 | 2.0 | 1.9 | 1.5 |
| 326 | 6.0 | 5.6 | 0.4 | 0.2 | 0.3 | 0.5 | 0.7 | 0.9 | 2.1 | 0.3 | 0.9 | 1.2 | 1.9 | 3.4 |
| | 7.0 | 8.0 | 0.8 | 1.0 | 0.7 | 1.0 | 1.0 | 1.5 | 1.9 | 0.6 | 1.6 | 2.6 | 2.8 | 4.0 |
| | 8.0 | 5.5 | 1.0 | 0.6 | 0.4 | 0.5 | 0.4 | 0.5 | 1.7 | 0.4 | 0.8 | 0.6 | 2.7 | 2.3 |
| | | 10.3 | 1.3 | 2.1 | 1.5 | 1.3 | 2.5 | 2.8 | 4.9 | 2.4 | 3.3 | 2.4 | 3.9 | 3.7 |
| | 8.5 | 10.7 | 2.6 | 2.5 | 2.3 | 1.7 | 3.4 | 4.2 | 5.0 | 2.0 | 3.5 | 2.7 | 4.3 | 4.3 |
| | 9.0 | 6.2 | 1.3 | 1.5 | 1.3 | 1.3 | 0.9 | 1.3 | 1.5 | 1.2 | 1.4 | 1.1 | 2.1 | 1.4 |
| | | 11.9 | 3.8 | 3.5 | 3.9 | 3.0 | 3.7 | 4.2 | 5.2 | 3.5 | 3.2 | 3.2 | 4.9 | 3.7 |
| | 10.0 | 13.7 | 4.7 | 6.6 | 5.0 | 4.7 | 4.6 | 5.5 | 4.6 | 6.0 | 4.6 | 6.2 | 6.4 | 5.6 |
| 17 | 6.0 | 4.7 | 0.2 | 0.2 | 0.2 | 0.1 | 0.2 | 0.9 | 0.3 | 0.1 | 0.2 | 0.4 | 0.4 | 0.3 |
| | 7.0 | 7.3 | 0.6 | 0.4 | 0.4 | 0.4 | 0.7 | 1.4 | 0.8 | 0.6 | 0.8 | 0.5 | 0.9 | 0.6 |
| | 8.0 | 5.1 | 0.5 | 1.1 | 0.4 | 0.2 | 0.3 | 1.3 | 2.0 | 0.2 | 0.9 | 0.9 | 0.8 | 1.9 |
| | | 8.9 | 0.6 | 0.9 | 0.5 | 0.5 | 1.1 | 2.9 | 1.3 | 0.6 | 1.3 | 0.7 | 1.4 | 2.3 |
| | | 9.8 | 1.4 | 1.6 | 1.6 | 0.9 | 1.6 | 3.0 | 1.9 | 1.4 | 2.1 | 1.0 | 1.6 | 3.2 |
| | 9.5 | 12.2 | 4.4 | 3.6 | 4.9 | 4.2 | 3.3 | 3.5 | 3.7 | 3.7 | 3.7 | 1.8 | 2.1 | 3.9 |

(Continued)

Table 18 (Concluded)

| Test Wave | | | Wave Height, ft | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Direction deg | Period sec | Height ft | Gage 13 | Gage 14 | Gage 15 | Gage 16 | Gage 17 | Gage 18 | Gage 19 | Gage 20 | Gage 21 | Gage 22 | Gage 23 | Gage 24 | Gage 25 |
| 279 | 6.0 | 3.9 | 0.4 | 0.5 | 0.6 | 0.7 | <0.1 | 0.6 | 0.3 | 0.3 | 0.4 | 0.3 | 0.2 | 0.2 | 0.2 |
| | 7.0 | 5.5 | 0.7 | 0.8 | 1.2 | 1.2 | 0.3 | 0.6 | 0.4 | 0.2 | 0.3 | 0.6 | 0.9 | 0.3 | 0.4 |
| | 8.0 | 6.6 | 0.5 | 0.6 | 1.1 | 6.2 | 1.2 | 1.5 | 1.4 | 0.8 | 0.5 | 0.7 | 0.3 | 0.6 | 1.4 |
| | 9.0 | 4.3 | 0.3 | 1.0 | 0.5 | 3.0 | 1.0 | 1.5 | 0.5 | 0.6 | 0.3 | 0.7 | 0.2 | 0.6 | 1.0 |
| | | 8.1 | 0.9 | 1.3 | 1.1 | 7.3 | 1.8 | 2.5 | 1.1 | 2.2 | 1.0 | 0.8 | 0.9 | 1.3 | 1.6 |
| | | 8.6 | 1.3 | 1.3 | 1.3 | 8.2 | 1.7 | 2.7 | 1.2 | 2.6 | 1.3 | 1.0 | 0.8 | 1.5 | 2.0 |
| | 10.0 | 9.2 | 1.8 | 2.5 | 4.9 | 6.8 | 3.0 | 2.7 | 2.6 | 2.9 | 0.9 | 2.6 | 1.1 | 1.9 | 2.6 |
| 326 | 6.0 | 5.6 | 2.7 | 4.4 | 6.4 | 4.7 | 2.7 | 0.9 | 0.2 | 1.0 | 0.9 | 0.8 | 0.5 | 0.2 | 1.0 |
| | 7.0 | 8.0 | 4.4 | 6.9 | 9.4 | 10.5 | 5.4 | 2.1 | 1.6 | 0.8 | 1.7 | 0.8 | 2.3 | 0.7 | 2.5 |
| | 8.0 | 5.5 | 3.1 | 3.9 | 5.1 | 6.4 | 3.8 | 1.8 | 1.4 | 0.5 | 0.5 | 0.6 | 0.6 | 0.4 | 1.2 |
| | | 10.3 | 6.0 | 8.1 | 12.7 | 15.5 | 6.2 | 3.9 | 2.8 | 3.4 | 1.8 | 2.0 | 2.0 | 1.8 | 4.8 |
| | 8.5 | 10.7 | 7.4 | 9.8 | 13.3 | 13.6 | 5.5 | 3.9 | 2.1 | 5.0 | 3.0 | 3.0 | 3.4 | 2.2 | 4.4 |
| | 9.0 | 6.2 | 2.0 | 3.1 | 4.3 | 7.1 | 2.6 | 2.4 | 0.9 | 1.5 | 0.9 | 1.1 | 0.4 | 0.7 | 2.1 |
| | | 11.9 | 6.7 | 9.4 | 13.8 | 19.5 | 5.0 | 5.5 | 3.0 | 4.0 | 2.5 | 2.6 | 2.0 | 2.8 | 3.4 |
| | 10.0 | 13.7 | 8.1 | 9.8 | 16.4 | 23.3 | 8.0 | 7.2 | 5.2 | 6.5 | 2.5 | 4.6 | 2.5 | 3.3 | 5.1 |
| 17 | 6.0 | 4.7 | 0.3 | 0.8 | 1.6 | 2.3 | 0.4 | 0.7 | 0.2 | 0.5 | 0.4 | 0.2 | 0.1 | <0.1 | 0.3 |
| | 7.0 | 7.3 | 1.1 | 2.2 | 2.2 | 5.5 | 0.5 | 0.2 | 0.2 | 0.3 | 0.3 | 0.2 | 0.5 | 0.2 | 0.7 |
| | 8.0 | 5.1 | 2.2 | 1.9 | 2.6 | 4.5 | 1.4 | 0.7 | 0.6 | 0.3 | 0.1 | 0.2 | 0.3 | 0.1 | 0.3 |
| | | 8.9 | 3.1 | 3.5 | 3.9 | 6.3 | 1.7 | 1.6 | 0.9 | 0.7 | 0.3 | 0.5 | 0.5 | 0.5 | 0.8 |
| | | 9.8 | 3.3 | 4.1 | 3.7 | 5.1 | 2.2 | 1.1 | 0.7 | 1.0 | 0.5 | 1.0 | 0.8 | 0.9 | 1.2 |
| | 9.5 | 12.2 | 3.7 | 4.5 | 7.4 | 17.4 | 3.3 | 1.9 | 1.6 | 2.5 | 1.7 | 2.1 | 0.8 | 1.6 | 1.7 |

Table 19

Wave Heights for Fair-Weather Plan 4D,

+2.6 ft swl, River Discharge 8,000 cfs

| Test Wave Direction deg | Test Wave Period sec | Test Wave Height ft | Wave Height, ft Gage 1 | Gage 2 | Gage 3 | Gage 4 | Gage 5 | Gage 6 | Gage 7 | Gage 8 | Gage 9 | Gage 10 | Gage 11 | Gage 12 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 279 | 6.0 | 3.9 | 0.3 | 0.2 | 0.1 | 0.3 | 0.2 | <0.1 | 0.3 | 0.2 | 0.2 | 0.2 | 0.2 | 0.1 |
| | 7.0 | 5.5 | 0.3 | 0.3 | 0.5 | 0.5 | 0.3 | 0.2 | 0.3 | 0.7 | 0.6 | 0.1 | 0.2 | 0.6 |
| | 8.0 | 6.6 | 0.9 | 0.5 | 0.7 | 0.7 | 0.8 | 0.5 | 0.4 | 0.7 | 0.9 | 0.5 | 0.5 | 0.9 |
| | 9.0 | 4.3 | 0.5 | 0.5 | 1.0 | 0.4 | 0.4 | 0.6 | 0.8 | 0.8 | 0.2 | 0.2 | 0.2 | 0.4 |
| | | 8.1 | 1.7 | 1.9 | 2.0 | 1.4 | 0.8 | 1.2 | 1.2 | 2.3 | 1.1 | 1.4 | 1.1 | 1.2 |
| | | 8.6 | 1.7 | 2.5 | 1.9 | 2.1 | 1.3 | 1.3 | 1.5 | 2.5 | 1.1 | 1.5 | 1.2 | 1.7 |
| | 10.0 | 9.2 | 3.5 | 2.3 | 3.5 | 2.2 | 2.3 | 2.0 | 1.7 | 2.4 | 2.5 | 1.8 | 1.5 | 1.2 |
| 326 | 6.0 | 5.6 | 0.9 | 0.5 | 0.4 | 0.5 | 0.3 | 0.9 | 0.8 | 0.4 | 0.4 | 1.3 | 3.0 | 3.7 |
| | 7.0 | 8.0 | 0.8 | 1.1 | 0.7 | 0.9 | 1.0 | 1.2 | 2.0 | 0.7 | 1.5 | 2.2 | 2.2 | 3.2 |
| | 8.0 | 5.5 | 1.0 | 0.4 | 0.3 | 0.5 | 0.5 | 0.4 | 1.6 | 0.4 | 0.9 | 1.0 | 2.3 | 2.5 |
| | | 10.3 | 1.3 | 1.8 | 1.3 | 1.2 | 2.0 | 2.8 | 4.5 | 2.4 | 3.0 | 2.7 | 3.7 | 4.4 |
| | 8.5 | 10.7 | 2.8 | 3.0 | 2.6 | 1.8 | 3.5 | 3.8 | 5.4 | 2.1 | 4.4 | 2.9 | 4.6 | 4.9 |
| | 9.0 | 6.2 | 1.1 | 1.3 | 1.5 | 1.1 | 0.8 | 1.1 | 1.7 | 1.0 | 1.0 | 1.4 | 3.0 | 2.8 |
| | | 11.9 | 4.0 | 4.1 | 3.5 | 2.9 | 3.5 | 3.9 | 5.0 | 4.1 | 3.4 | 4.4 | 5.7 | 5.8 |
| | 10.0 | 13.7 | 4.7 | 6.1 | 5.2 | 5.5 | 4.3 | 5.7 | 5.1 | 6.5 | 4.9 | 6.3 | 7.4 | 5.8 |
| 17 | 6.0 | 4.7 | 0.2 | 0.2 | 0.1 | 0.2 | 0.2 | 0.8 | 0.6 | <0.1 | 0.3 | 0.5 | 0.6 | 0.5 |
| | 7.0 | 7.3 | 0.3 | 0.3 | 0.2 | 0.3 | 0.4 | 1.6 | 1.2 | 0.8 | 0.4 | 0.6 | 1.0 | 1.3 |
| | 8.0 | 5.1 | 0.5 | 0.4 | 0.7 | 0.4 | 0.4 | 0.8 | 2.2 | 0.4 | 0.6 | 0.6 | 0.5 | 1.3 |
| | | 8.9 | 1.0 | 1.2 | 0.7 | 0.4 | 0.7 | 2.2 | 2.4 | 1.2 | 1.6 | 0.9 | 1.0 | 1.9 |
| | | 9.8 | 1.5 | 1.8 | 1.5 | 0.9 | 1.1 | 2.3 | 2.2 | 1.5 | 1.7 | 1.1 | 0.9 | 2.1 |
| | 9.5 | 12.2 | 2.7 | 2.6 | 2.8 | 2.6 | 2.9 | 2.7 | 3.1 | 2.3 | 2.7 | 1.9 | 1.7 | 3.8 |

(Continued)

Table 19 (Concluded)

| Test Wave | | | Wave Height, ft | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Direction deg | Period sec | Height ft | Gage 13 | Gage 14 | Gage 15 | Gage 16 | Gage 17 | Gage 18 | Gage 19 | Gage 20 | Gage 21 | Gage 22 | Gage 23 | Gage 24 | Gage 25 |
| 279 | 6.0 | 3.9 | 0.2 | 0.3 | 0.5 | 0.8 | 0.1 | 0.5 | 0.3 | 0.3 | 0.4 | 0.3 | 0.1 | 0.2 | 0.2 |
| | 7.0 | 5.5 | 0.8 | 0.6 | 1.3 | 1.5 | 0.2 | 0.6 | 0.5 | 0.3 | 0.3 | 0.6 | 1.0 | 0.2 | 0.4 |
| | 8.0 | 6.6 | 0.8 | 0.6 | 0.9 | 5.4 | 0.9 | 1.2 | 1.2 | 0.6 | 0.4 | 0.5 | 0.3 | 0.6 | 1.2 |
| | 9.0 | 4.3 | 0.3 | 1.1 | 0.3 | 2.9 | 0.8 | 1.3 | 0.4 | 0.6 | 0.2 | 0.6 | 0.2 | 0.5 | 0.7 |
| | | 8.1 | 1.1 | 1.4 | 1.8 | 7.7 | 1.7 | 2.6 | 1.2 | 2.6 | 1.2 | 1.2 | 1.0 | 1.2 | 1.5 |
| | | 8.6 | 1.1 | 1.2 | 1.2 | 7.7 | 1.7 | 2.8 | 1.2 | 1.9 | 1.2 | 1.0 | 0.7 | 1.5 | 2.2 |
| | 10.0 | 9.2 | 1.6 | 2.4 | 4.7 | 7.1 | 2.9 | 2.4 | 2.4 | 2.7 | 0.9 | 2.6 | 0.9 | 1.8 | 2.6 |
| 326 | 6.0 | 5.6 | 2.9 | 4.0 | 5.7 | 4.0 | 2.7 | 1.6 | 0.7 | 1.0 | 1.1 | 0.8 | 0.3 | 0.4 | 0.8 |
| | 7.0 | 8.0 | 4.3 | 5.8 | 8.1 | 8.6 | 4.2 | 1.7 | 1.3 | 0.9 | 1.3 | 1.0 | 2.4 | 0.7 | 2.4 |
| | 8.0 | 5.5 | 3.3 | 3.8 | 5.2 | 6.8 | 3.8 | 2.0 | 1.7 | 0.5 | 0.5 | 0.6 | 0.7 | 0.4 | 1.3 |
| | | 10.3 | 6.5 | 7.9 | 13.4 | 15.9 | 6.6 | 3.6 | 2.8 | 3.0 | 1.8 | 1.6 | 2.2 | 1.9 | 4.2 |
| | 8.5 | 10.7 | 8.3 | 10.6 | 13.7 | 16.6 | 6.1 | 4.8 | 2.4 | 5.4 | 2.6 | 2.9 | 3.7 | 2.4 | 4.5 |
| | 9.0 | 6.2 | 2.7 | 3.9 | 5.2 | 8.9 | 2.2 | 2.1 | 1.0 | 1.8 | 1.1 | 1.0 | 0.5 | 0.6 | 1.7 |
| | | 11.9 | 8.4 | 9.9 | 14.2 | 22.9 | 5.7 | 5.9 | 3.4 | 4.3 | 2.0 | 3.0 | 2.3 | 2.5 | 3.8 |
| | 10.0 | 13.7 | 8.5 | 10.6 | 15.4 | 22.9 | 8.9 | 6.8 | 5.1 | 6.0 | 2.8 | 4.5 | 2.4 | 3.3 | 4.8 |
| 17 | 6.0 | 4.7 | 0.8 | 0.7 | 1.5 | 3.0 | 0.5 | 0.3 | <0.1 | <0.1 | 0.3 | <0.1 | <0.1 | <0.1 | 0.2 |
| | 7.0 | 7.3 | 0.9 | 2.1 | 2.5 | 6.6 | 0.5 | 0.6 | 0.3 | 0.2 | 0.2 | 0.4 | 0.5 | 0.2 | 0.6 |
| | 8.0 | 5.1 | 1.8 | 2.1 | 2.3 | 3.7 | 0.9 | 0.4 | 0.4 | 0.5 | 0.1 | 0.3 | 0.2 | 0.2 | 0.6 |
| | | 8.9 | 2.2 | 2.9 | 4.1 | 4.3 | 1.8 | 0.9 | 0.7 | 0.7 | 0.3 | 0.4 | 0.6 | 0.4 | 0.6 |
| | | 9.8 | 1.6 | 3.2 | 3.4 | 4.5 | 1.9 | 1.2 | 0.8 | 0.9 | 0.4 | 0.6 | 0.6 | 0.6 | 1.2 |
| | 9.5 | 12.2 | 3.8 | 4.5 | 6.5 | 15.0 | 2.5 | 1.9 | 1.1 | 2.0 | 1.3 | 1.1 | 0.6 | 1.0 | 1.3 |

Table 20

Wave Heights for Fair-Weather Plan 4D,

+4.8 ft swl, River Discharge 800 cfs

| Test Wave Direction deg | Test Wave Period sec | Test Wave Height ft | Wave Height, ft Gage 1 | Gage 2 | Gage 3 | Gage 4 | Gage 5 | Gage 6 | Gage 7 | Gage 8 | Gage 9 | Gage 10 | Gage 11 | Gage 12 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 279 | 6.0 | 3.9 | 0.2 | 0.3 | 0.2 | 0.3 | 0.2 | 0.1 | 0.4 | 0.2 | 0.1 | 0.2 | 0.1 | 0.5 |
| | 7.0 | 5.5 | 0.2 | 0.5 | 0.4 | 0.3 | 0.2 | 0.2 | 0.3 | 0.3 | 0.3 | 0.2 | 0.4 | 0.7 |
| | 8.0 | 6.6 | 0.5 | 2.3 | 1.2 | 1.1 | 0.8 | 1.1 | 1.2 | 0.7 | 0.7 | 0.7 | 1.2 | 1.1 |
| | 9.0 | 4.3 | 0.5 | 1.0 | 1.4 | 0.5 | 0.4 | 0.5 | 0.4 | 0.8 | 0.6 | 0.3 | 0.4 | 0.7 |
| | | 8.1 | 3.8 | 2.1 | 2.4 | 1.6 | 1.6 | 1.7 | 1.7 | 1.8 | 1.4 | 0.9 | 0.8 | 1.1 |
| | | 8.6 | 3.2 | 2.7 | 2.6 | 1.6 | 1.5 | 1.9 | 2.6 | 2.5 | 2.0 | 1.4 | 1.2 | 2.2 |
| | 10.0 | 9.2 | 3.3 | 2.9 | 3.6 | 4.6 | 3.6 | 3.2 | 3.8 | 3.6 | 4.2 | 1.9 | 3.4 | 2.9 |
| 326 | 6.0 | 5.6 | 0.5 | 0.4 | 0.4 | 0.8 | 0.4 | 0.5 | 1.5 | 0.4 | 0 6 | 2.0 | 2.1 | 3.7 |
| | 7.0 | 8.0 | 1.2 | 1.4 | 1.5 | 1.4 | 1.4 | 2.1 | 3.7 | 0.9 | 2.9 | 2.8 | 2.6 | 4.4 |
| | 8.0 | 5.5 | 1.2 | 1.4 | 0.7 | 0.3 | 0.9 | 1.2 | 1.5 | 0.3 | 1.0 | 1.4 | 2.5 | 2.3 |
| | | 10.3 | 2.3 | 3.0 | 2.1 | 2.4 | 3.2 | 3.4 | 3.7 | 3.7 | 3.7 | 2.4 | 4.0 | 4.3 |
| | 8.5 | 10.7 | 2.1 | 2.9 | 1.8 | 2.0 | 3.6 | 5.3 | 5.3 | 4.4 | 4.3 | 2.6 | 4.1 | 4.6 |
| | 9.0 | 6.2 | 3.2 | 2.0 | 2.0 | 1.5 | 1.4 | 1.9 | 1.5 | 1.8 | 1.1 | 1.7 | 2.4 | 3.8 |
| | | 11.9 | 3.8 | 6.2 | 6.3 | 4.9 | 4.2 | 5.2 | 5.0 | 6.0 | 4.7 | 4.5 | 5.3 | 6.2 |
| | 10.0 | 13.7 | 5.8 | 8.6 | 7.9 | 9.0 | 5.6 | 5.8 | 6.7 | 9.6 | 6.3 | 4.7 | 5.7 | 6.0 |
| 17 | 6.0 | 4.7 | 0.2 | <0.1 | 0.3 | 0.4 | 0.8 | 1.3 | 0.9 | 0.3 | 0.4 | 0.5 | 0.6 | 0.6 |
| | 7.0 | 7.3 | 0.7 | 0.6 | 0.5 | 0.6 | 1.4 | 3.1 | 1.1 | 0.6 | 1.1 | 1.5 | 0.7 | 2.9 |
| | 8.0 | 5.1 | 1.0 | 1.1 | 0.7 | 0.6 | 1.4 | 2.3 | 2.7 | 0.7 | 1.5 | 1.0 | 1.1 | 1.4 |
| | | 8.9 | 2.6 | 3.1 | 2.0 | 1.8 | 2.3 | 2.2 | 2.3 | 1.8 | 1.7 | 1.4 | 1.6 | 3.1 |
| | | 9.8 | 1.7 | 2.7 | 1.9 | 1.6 | 2.8 | 2.4 | 2.4 | 2.6 | 1.3 | 1.3 | 2.5 | 3.0 |
| | 9.5 | 12.2 | 5.2 | 5.0 | 5.1 | 5.7 | 4.2 | 5.4 | 3.9 | 5.0 | 5.2 | 2.7 | 4.1 | 6.4 |

(Continued)

Table 20 (Concluded)

| Test Wave | | | Wave Height, ft | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Direction deg | Period sec | Height ft | Gage 13 | Gage 14 | Gage 15 | Gage 16 | Gage 17 | Gage 18 | Gage 19 | Gage 20 | Gage 21 | Gage 22 | Gage 23 | Gage 24 | Gage 25 |
| 279 | 6.0 | 3.9 | 0.6 | 0.5 | 0.8 | 0.9 | 0.4 | 1.0 | 0.4 | 0.8 | 0.6 | 0.6 | 0.6 | 0.7 | 0.3 |
| | 7.0 | 5.5 | 0.4 | 0.6 | 1.7 | 2.3 | 0.4 | 0.6 | 0.4 | 0.5 | <0.1 | 0.2 | 0.5 | 0.5 | 0.6 |
| | 8.0 | 6.6 | 0.9 | 2.2 | 2.0 | 5.8 | 1.6 | 1.5 | 0.9 | 1.1 | 1.0 | 0.6 | 0.8 | 0.8 | 1.3 |
| | 9.0 | 4.3 | 1.0 | 0.8 | 1.7 | 3.4 | 1.8 | 1.8 | 1.1 | 1.2 | 1.0 | 0.6 | 0.3 | 0.7 | 0.5 |
| | | 8.1 | 0.9 | 2.0 | 2.1 | 7.2 | 2.5 | 2.0 | 1.5 | 2.5 | 0.8 | 1.3 | 0.8 | 2.0 | 1.7 |
| | | 8.6 | 1.7 | 1.8 | 2.4 | 8.6 | 2.9 | 2.4 | 1.8 | 2.5 | 1.4 | 2.3 | 1.3 | 3.1 | 2.3 |
| | 10.0 | 9.2 | 4.5 | 2.7 | 3.4 | 6.9 | 2.6 | 3.3 | 1.8 | 3.8 | 1.7 | 3.9 | 3.1 | 4.9 | 2.9 |
| 326 | 6.0 | 5.6 | 3.6 | 4.6 | 6.8 | 4.4 | 2.5 | 0.9 | 0.2 | 1.1 | 1.4 | 0.9 | 0.3 | 1.0 | 1.1 |
| | 7.0 | 8.0 | 4.3 | 6.5 | 9.4 | 9.0 | 4.6 | 1.9 | 1.1 | 0.8 | 1.6 | 1.7 | 2.1 | 1.2 | 2.7 |
| | 8.0 | 5.5 | 2.7 | 3.6 | 5.6 | 6.1 | 4.2 | 1.4 | 0.8 | 1.5 | 1.4 | 0.8 | 1.9 | 0.4 | 3.0 |
| | | 10.3 | 7.1 | 9.3 | 13.6 | 19.1 | 7.0 | 4.9 | 2.6 | 4.1 | 2.4 | 2.5 | 4.9 | 2.8 | 5.0 |
| | 8.5 | 10.7 | 7.9 | 10.1 | 13.7 | 16.7 | 5.9 | 3.5 | 1.8 | 2.8 | 2.5 | 2.3 | 4.9 | 2.7 | 3.6 |
| | 9.0 | 6.2 | 4.5 | 3.6 | 5.3 | 9.2 | 4.8 | 2.2 | 2.9 | 2.3 | 1.9 | 1.6 | 1.2 | 1.2 | 2.5 |
| | | 11.9 | 8.4 | 9.7 | 14.5 | 24.8 | 8.1 | 7.3 | 6.3 | 6.6 | 3.2 | 5.6 | 3.0 | 4.1 | 6.2 |
| | 10.0 | 13.7 | 10.1 | 10.8 | 14.5 | 23.4 | 8.4 | 8.4 | 5.7 | 7.6 | 4.5 | 5.7 | 4.2 | 7.2 | 10.5 |
| 17 | 6.0 | 4.7 | 1.3 | 0.5 | 2.2 | 1.6 | 1.0 | 1.0 | 0.3 | 0.3 | 0.1 | 0.5 | 0.3 | 0.2 | 1.0 |
| | 7.0 | 7.3 | 2.8 | 1.9 | 3.6 | 6.8 | 1.2 | 1.6 | 0.4 | 0.4 | 0.5 | 0.5 | 1.1 | 0.3 | 1.1 |
| | 8.0 | 5.1 | 1.9 | 2.8 | 3.1 | 4.5 | 2.6 | 1.1 | 0.7 | 0.4 | 0.2 | 0.7 | 0.5 | 0.3 | 1.4 |
| | | 8.9 | 2.9 | 4.1 | 4.7 | 3.8 | 3.3 | 1.8 | 1.2 | 1.2 | 0.6 | 0.8 | 0.7 | 0.7 | 1.6 |
| | | 9.8 | 2.3 | 5.1 | 6.2 | 3.9 | 2.0 | 2.3 | 1.6 | 1.2 | 1.0 | 1.0 | 1.4 | 0.6 | 1.4 |
| | 9.5 | 12.2 | 6.9 | 6.3 | 9.3 | 15.8 | 3.5 | 4.9 | 3.9 | 2.9 | 1.8 | 2.6 | 1.2 | 3.8 | 2.9 |

Table 21

Wave Heights for Fair-Weather Plan 4D,

+4.8 swl, River Discharge 8,000 cfs

| Test Wave | | | Wave Height, ft | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Direction deg | Period sec | Height ft | Gage 1 | Gage 2 | Gage 3 | Gage 4 | Gage 5 | Gage 6 | Gage 7 | Gage 8 | Gage 9 | Gage 10 | Gage 11 | Gage 12 |
| 279 | 6.0 | 3.9 | 0.2 | 0.3 | 0.2 | 0.4 | 0.1 | 0.2 | 0.3 | 0.2 | 0.2 | 0.2 | 0.2 | 0.3 |
| | 7.0 | 5.5 | 0.2 | 0.4 | 0.3 | 0.3 | 0.2 | 0.2 | 0.3 | 0.2 | 0.3 | 0.2 | 0.3 | 0.5 |
| | 8.0 | 6.6 | 0.5 | 1.9 | 1.1 | 1.0 | 0.9 | 0.9 | 1.2 | 0.8 | 0.8 | 0.6 | 1.0 | 1.0 |
| | 9.0 | 4.3 | 0.4 | 0.6 | 1.4 | 0.4 | 0.6 | 0.5 | 0.4 | 0.6 | 0.6 | 0.2 | 0.3 | 0.4 |
| | | 8.1 | 3.8 | 1.9 | 2.5 | 1.6 | 1.1 | 1.9 | 2.0 | 2.5 | 1.9 | 0.5 | 0.7 | 1.0 |
| | | 8.6 | 3.4 | 2.7 | 2.7 | 1.5 | 1.7 | 1.9 | 2.7 | 2.9 | 1.8 | 1.3 | 1.3 | 1.3 |
| | 10.0 | 9.2 | 2.8 | 2.8 | 3.6 | 4.7 | 2.6 | 3.4 | 3.1 | 3.8 | 4.1 | 1.4 | 3.3 | 3.2 |
| 326 | 6.0 | 5.6 | 0.4 | 0.3 | 0.4 | 0.8 | 0.4 | 0.7 | 1.7 | 0.5 | 0.4 | 2.0 | 2.5 | 3.5 |
| | 7.0 | 8.0 | 0.8 | 1.7 | 1.5 | 1.4 | 1.6 | 2.2 | 3.6 | 0.8 | 1.9 | 3.1 | 3.5 | 4.5 |
| | 8.0 | 5.5 | 1.2 | 1.2 | 0.8 | 0.5 | 0.9 | 1.0 | 1.6 | 0.7 | 1.1 | 1.8 | 2.7 | 2.6 |
| | | 10.3 | 1.8 | 2.9 | 2.4 | 2.1 | 3.1 | 3.9 | 4.5 | 4.2 | 3.9 | 2.8 | 4.3 | 4.2 |
| | 8.5 | 10.7 | 2.6 | 4.1 | 3.5 | 2.7 | 4.3 | 6.1 | 5.4 | 3.7 | 3.0 | 3.8 | 5.6 | 5.4 |
| | 9.0 | 6.2 | 2.8 | 1.7 | 2.3 | 1.5 | 1.4 | 1.5 | 1.7 | 2.4 | 1.6 | 2.3 | 3.1 | 3.6 |
| | | 11.9 | 4.1 | 5.1 | 5.6 | 4.7 | 4.7 | 5.1 | 4.9 | 6.1 | 4.9 | 4.6 | 5.7 | 5.5 |
| | 10.0 | 13.7 | 6.1 | 8.2 | 8.6 | 8.6 | 6.1 | 5.3 | 6.3 | 9.2 | 6.2 | 4.9 | 5.7 | 6.9 |
| 17 | 6.0 | 4.7 | 0.2 | 0.1 | 0.2 | 0.5 | 0.8 | 1.3 | 1.1 | 0.1 | 0.4 | 0.2 | 0.7 | 1.1 |
| | 7.0 | 7.3 | 0.6 | 0.4 | 0.5 | 0.6 | 1.0 | 3.0 | 1.1 | 0.4 | 0.8 | 1.2 | 0.9 | 1.8 |
| | 8.0 | 5.1 | 1.0 | 1.2 | 0.8 | 0.6 | 1.4 | 2.3 | 2.3 | 0.5 | 1.6 | 0.8 | 0.6 | 1.7 |
| | | 8.9 | 2.9 | 3.0 | 2.0 | 1.6 | 2.5 | 2.5 | 2.2 | 1.9 | 2.2 | 1.4 | 1.3 | 3.3 |
| | | 9.8 | 1.6 | 1.5 | 1.4 | 1.4 | 2.7 | 2.4 | 1.7 | 2.6 | 1.0 | 1.5 | 1.7 | 3.2 |
| | 9.5 | 12.2 | 6.2 | 7.5 | 6.3 | 5.1 | 5.2 | 5.0 | 3.6 | 4.6 | 4.7 | 3.3 | 4.1 | 5.1 |

(Continued)

Table 21 (Concluded)

| Test Wave | | | Wave Height, ft | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Direction deg | Period sec | Height ft | Gage 13 | Gage 14 | Gage 15 | Gage 16 | Gage 17 | Gage 18 | Gage 19 | Gage 20 | Gage 21 | Gage 22 | Gage 23 | Gage 24 | Gage 25 |
| 279 | 6.0 | 3.9 | 0.4 | 0.3 | 0.7 | 1.0 | 0.4 | 1.0 | 0.4 | 0.8 | 0.8 | 0.6 | 0.7 | 0.4 | 0.5 |
| | 7.0 | 5.5 | 0.5 | 0.4 | 1.5 | 2.6 | 0.4 | 0.5 | 0.3 | 0.4 | 0.2 | 0.3 | 0.5 | 0.4 | 0.6 |
| | 8.0 | 6.6 | 0.5 | 1.8 | 1.9 | 5.7 | 1.7 | 1.2 | 0.8 | 0.9 | 0.8 | 0.6 | 0.8 | 0.7 | 1.3 |
| | 9.0 | 4.3 | 0.7 | 0.5 | 0.8 | 3.1 | 1.5 | 1.6 | 0.9 | 0.9 | 1.0 | 0.6 | 0.3 | 0.8 | 0.7 |
| | | 8.1 | 1.2 | 2.2 | 1.6 | 5.9 | 2.1 | 1.7 | 1.3 | 1.9 | 0.8 | 1.1 | 0.9 | 2.0 | 1.8 |
| | | 8.6 | 1.9 | 1.5 | 2.0 | 8.0 | 2.9 | 1.8 | 1.5 | 2.1 | 1.3 | 2.2 | 1.2 | 3.8 | 2.2 |
| | 10.0 | 9.2 | 3.8 | 2.6 | 3.4 | 6.4 | 2.8 | 3.4 | 2.3 | 4.2 | 2.0 | 4.3 | 1.9 | 4.4 | 3.1 |
| 326 | 6.0 | 5.6 | 4.0 | 5.0 | 7.3 | 4.6 | 2.6 | 0.7 | 0.3 | 1.2 | 1.2 | 1.2 | 0.4 | 0.8 | 1.5 |
| | 7.0 | 8.0 | 5.4 | 7.0 | 9.9 | 9.3 | 3.7 | 1.8 | 1.2 | 1.1 | 1.9 | 1.7 | 1.7 | 1.4 | 2.2 |
| | 8.0 | 5.5 | 3.3 | 3.8 | 5.8 | 6.4 | 4.2 | 1.4 | 0.8 | 1.3 | 1.6 | 0.5 | 1.8 | 0.6 | 2.7 |
| | | 10.3 | 7.0 | 9.9 | 13.6 | 21.1 | 7.1 | 4.5 | 2.1 | 4.1 | 2.2 | 2.2 | 3.8 | 2.9 | 4.6 |
| | 8.5 | 10.7 | 6.8 | 10.0 | 14.4 | 2.43 | 6.3 | 5.6 | 3.4 | 4.9 | 2.8 | 3.0 | 5.4 | 2.9 | 5.9 |
| | 9.0 | 6.2 | 5.3 | 4.5 | 6.1 | 10.5 | 5.0 | 2.6 | 2.9 | 2.4 | 1.1 | 1.8 | 1.3 | 1.4 | 3.0 |
| | | 11.9 | 8.5 | 10.1 | 14.1 | 23.0 | 7.5 | 7.5 | 6.4 | 6.1 | 3.2 | 5.4 | 3.6 | 5.4 | 6.0 |
| | 10.0 | 13.7 | 9.0 | 12.1 | 14.1 | 21.7 | 8.3 | 8.3 | 5.8 | 7.7 | 4.7 | 6.6 | 4.5 | 6.9 | 10.7 |
| 17 | 6.0 | 4.7 | 0.9 | 0.7 | 2.2 | 1.7 | 0.9 | 0.9 | 0.3 | 0.3 | 0.1 | 0.4 | 0.2 | 0.2 | 1.3 |
| | 7.0 | 7.3 | 2.4 | 2.0 | 3.0 | 6.5 | 1.3 | 1.5 | 0.4 | 0.4 | 0.6 | 0.5 | 1.1 | 0.4 | 0.9 |
| | 8.0 | 5.1 | 2.2 | 2.6 | 2.9 | 3.9 | 2.6 | 1.2 | 0.7 | 0.4 | 0.3 | 0.6 | 0.5 | 0.4 | 1.3 |
| | | 8.9 | 2.8 | 3.2 | 5.6 | 3.0 | 3.2 | 1.8 | 1.3 | 1.3 | 0.7 | 0.8 | 0.7 | 0.7 | 1.7 |
| | | 9.8 | 2.2 | 5.2 | 6.5 | 3.7 | 2.1 | 2.4 | 1.5 | 1.2 | 0.8 | 0.9 | 1.4 | 0.6 | 2.0 |
| | 9.5 | 12.2 | 5.8 | 6.0 | 10.2 | 15.5 | 3.9 | 4.5 | 3.5 | 3.7 | 1.9 | 2.5 | 1.6 | 3.5 | 3.3 |

Table 22

Comparison of Wave Heights for Existing Conditions (EC), Fair-Weather Plan 4D, and Fair-Weather Plans 5-5G for Representative Test Waves from 279 deg, River Discharge 800 cfs

| Plan No. | Wave Height, ft Gage 13 | Gage 14 | Gage 15 | Gage 16 | Gage 17 | Gage 18 | Gage 20 | Gage 22 |
|---|---|---|---|---|---|---|---|---|
| 9-sec, 8.6-ft Waves; +2.6 ft swl | | | | | | | | |
| EC | 2.3 | 5.5 | 5.6 | 10.5 | 2.0 | 3.4 | 2.5 | 1.4 |
| 4D | 1.3 | 1.3 | 1.3 | 8.2 | 1.7 | 2.7 | 2.6 | 1.0 |
| 5 | 1.1 | 1.5 | 2.5 | 9.4 | 2.4 | 3.3 | 2.5 | 1.5 |
| 5A | 1.1 | 1.6 | 1.4 | 8.4 | 1.4 | 2.9 | 2.2 | 1.8 |
| 5B | 1.5 | 1.6 | 3.0 | 9.9 | 2.0 | 3.1 | 3.1 | 2.0 |
| 5C | 1.3 | 1.4 | 2.1 | 9.1 | 1.5 | 2.7 | 2.8 | 1.9 |
| 5D | 1.6 | 1.7 | 2.3 | 9.9 | 1.6 | 3.3 | 3.4 | 1.7 |
| 5E | 1.9 | 2.8 | 3.0 | 9.1 | 2.1 | 4.1 | 4.1 | 1.8 |
| 5F | 1.5 | 2.6 | 2.7 | 8.4 | 1.6 | 3.8 | 3.7 | 1.7 |
| 5G | 1.6 | 2.4 | 2.2 | 7.4 | 1.5 | 3.4 | 3.0 | 1.6 |
| 10-sec, 9.2-ft Waves; +2.6 ft swl | | | | | | | | |
| EC | 2.9 | 7.8 | 7.1 | 11.9 | 4.6 | 4.0 | 4.2 | 3.2 |
| 4D | 1.8 | 2.5 | 4.9 | 6.8 | 3.0 | 2.7 | 2.9 | 2.6 |
| 5 | 2.0 | 3.1 | 4.3 | 6.0 | 2.9 | 3.6 | 3.3 | 3.5 |
| 5A | 1.9 | 3.2 | 4.1 | 6.0 | 2.6 | 3.5 | 3.2 | 3.8 |
| 5B | 2.0 | 3.0 | 4.6 | 6.1 | 2.3 | 4.1 | 3.7 | 3.7 |
| 5C | 2.4 | 3.0 | 4.6 | 5.9 | 2.3 | 4.4 | 4.1 | 3.4 |
| 5D | 3.5 | 2.8 | 4.7 | 5.7 | 3.1 | 4.7 | 4.6 | 3.5 |
| 5E | 3.4 | 4.1 | 6.9 | 6.6 | 2.6 | 6.1 | 5.5 | 4.0 |
| 5F | 2.6 | 3.6 | 4.6 | 6.0 | 1.7 | 5.2 | 5.5 | 3.7 |
| 5G | 3.2 | 2.1 | 4.2 | 4.9 | 2.3 | 3.6 | 3.9 | 3.6 |
| 9-sec, 8.6-ft Waves; +4.8 ft swl | | | | | | | | |
| EC | 3.7 | 4.7 | 6.4 | 13.1 | 2.0 | 4.7 | 5.7 | 4.4 |
| 4D | 1.7 | 1.8 | 2.4 | 8.6 | 2.9 | 2.4 | 2.5 | 2.3 |
| 5C | 2.2 | 1.7 | 2.0 | 7.6 | 2.2 | 2.5 | 3.4 | 3.0 |
| 5E | 3.8 | 3.2 | 4.0 | 8.5 | 3.5 | 3.8 | 4.6 | 3.0 |
| 10-sec, 9.2-ft Waves; +4.8 ft swl | | | | | | | | |
| EC | 3.3 | 8.1 | 7.7 | 13.4 | 2.8 | 5.7 | 6.1 | 6.1 |
| 4D | 4.5 | 2.7 | 3.4 | 6.9 | 2.6 | 3.3 | 3.8 | 3.9 |
| 5C | 4.1 | 3.2 | 3.5 | 6.1 | 3.2 | 4.1 | 4.4 | 4.4 |
| 5E | 3.6 | 3.8 | 6.9 | 7.5 | 4.1 | 6.3 | 6.3 | 5.6 |

Table 23

Wave Heights for Severe-Weather Plan 6 for Test Waves from 326 and 17 deg, River Discharge 800 cfs

| Test Wave Direction deg | Test Wave Period sec | Test Wave Height ft | Gage 1 | Gage 2 | Gage 3 | Gage 4 | Gage 5 | Gage 6 | Gage 7 | Gage 8 | Gage 9 | Gage 10 | Gage 11 | Gage 12 | Gage 13 | Gage 14 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | +2.6 ft swl | | | | | | | | | |
| 326 | 6.0 | 5.6 | 0.2 | 0.2 | 0.1 | 0.3 | 0.3 | 0.2 | 0.8 | 0.2 | 0.3 | 0.4 | 0.6 | 0.9 | 0.6 | 1.1 |
| | 7.0 | 8.0 | 1.0 | 0.8 | 0.9 | 0.7 | 0.3 | 0.5 | 1.3 | 0.3 | 0.3 | 1.2 | 0.6 | 1.2 | 1.2 | 1.0 |
| | 8.0 | 5.5 | 0.8 | 0.4 | 0.2 | 0.3 | 0.2 | 0.3 | 0.6 | 0.4 | 0.3 | 0.7 | 1.1 | 1.3 | 1.4 | 1.4 |
| | | 10.3 | 1.3 | 1.3 | 1.2 | 1.4 | 1.3 | 1.1 | 2.1 | 1.5 | 1.1 | 1.5 | 1.3 | 1.6 | 2.6 | 3.0 |
| | 8.5 | 10.7 | 3.3 | 2.7 | 2.1 | 1.7 | 1.4 | 1.2 | 2.4 | 2.8 | 1.3 | 1.4 | 1.5 | 2.0 | 2.1 | 3.5 |
| | 9.0 | 6.2 | 1.3 | 0.7 | 0.9 | 0.6 | 0.6 | 0.9 | 1.0 | 0.8 | 0.5 | 0.9 | 1.2 | 1.1 | 2.0 | 1.9 |
| | | 11.9 | 2.9 | 3.4 | 3.7 | 3.9 | 2.1 | 1.6 | 2.4 | 3.5 | 1.6 | 1.7 | 2.2 | 2.7 | 3.5 | 3.9 |
| | 10.0 | 13.7 | 3.8 | 3.3 | 5.0 | 5.0 | 3.5 | 3.0 | 3.9 | 5.3 | 3.0 | 2.9 | 3.5 | 3.3 | 5.0 | 5.9 |
| 17 | 6.0 | 4.7 | 0.1 | <0.1 | <0.1 | 0.1 | 0.1 | 0.7 | 0.7 | <0.1 | <0.1 | 0.4 | 0.4 | 0.5 | 0.8 | 0.6 |
| | 7.0 | 7.3 | 0.8 | 0.6 | 1.0 | 0.9 | 0.9 | 1.7 | 0.9 | 0.7 | 0.8 | 1.0 | 0.4 | 1.4 | 2.0 | 1.6 |
| | 8.0 | 5.1 | 0.5 | 0.6 | 0.2 | 0.3 | 0.5 | 1.3 | 1.1 | 0.3 | 0.4 | 0.5 | 0.9 | 1.3 | 1.7 | 2.1 |
| | | 8.9 | 1.2 | 0.8 | 0.8 | 0.8 | 0.7 | 2.3 | 1.6 | 0.5 | 1.0 | 1.3 | 0.6 | 2.6 | 2.1 | 4.3 |
| | | 9.8 | 1.7 | 1.6 | 1.3 | 1.1 | 1.8 | 2.0 | 1.4 | 1.0 | 1.9 | 1.1 | 1.2 | 2.4 | 2.4 | 3.5 |
| | 9.5 | 12.2 | 2.2 | 2.8 | 2.0 | 2.1 | 2.2 | 2.8 | 2.5 | 1.5 | 3.0 | 2.0 | 3.6 | 3.8 | 5.9 | 5.0 |
| | | | | | | | +4.8 ft swl | | | | | | | | | |
| 326 | 6.0 | 5.6 | 0.4 | 0.5 | 0.8 | 0.9 | 0.3 | 0.6 | 1.1 | 0.6 | 0.2 | 1.2 | 1.0 | 1.6 | 1.3 | 1.5 |
| | 7.0 | 8.0 | 2.1 | 1.5 | 1.5 | 1.6 | 0.8 | 0.6 | 1.8 | 1.1 | 1.5 | 1.9 | 0.9 | 1.5 | 1.8 | 1.7 |
| | 8.0 | 5.5 | 1.6 | 0.5 | 0.5 | 0.5 | 0.4 | 0.8 | 1.4 | 0.7 | 0.6 | 1.7 | 1.0 | 1.6 | 2.8 | 1.9 |
| | | 10.3 | 2.0 | 2.9 | 1.8 | 2.2 | 3.0 | 2.4 | 3.0 | 4.7 | 2.0 | 1.8 | 1.5 | 2.2 | 4.8 | 3.4 |
| | 8.5 | 10.7 | 2.8 | 4.4 | 3.3 | 4.4 | 3.0 | 2.2 | 3.7 | 3.2 | 2.7 | 1.5 | 3.3 | 2.8 | 4.0 | 4.5 |
| | 9.0 | 6.2 | 2.4 | 1.7 | 2.4 | 1.8 | 1.3 | 0.9 | 1.5 | 1.9 | 1.5 | 1.5 | 1.8 | 1.9 | 2.6 | 3.1 |
| | | 11.9 | 3.2 | 7.0 | 7.3 | 4.7 | 4.7 | 2.9 | 3.9 | 7.8 | 2.8 | 2.1 | 2.7 | 3.8 | 5.2 | 4.5 |
| | 10.0 | 13.7 | 5.3 | 5.6 | 7.3 | 9.2 | 5.6 | 4.9 | 5.8 | 9.0 | 4.9 | 3.8 | 3.7 | 4.3 | 6.9 | 9.8 |
| 17 | 6.0 | 4.7 | 0.3 | 0.3 | 0.3 | 0.2 | 0.8 | 1.1 | 0.5 | 0.5 | 0.5 | 0.9 | 0.7 | 1.2 | 1.2 | 1.2 |
| | 7.0 | 7.3 | 0.6 | 0.7 | 1.2 | 1.1 | 1.5 | 2.3 | 1.8 | 0.8 | 1.2 | 1.7 | 1.2 | 2.6 | 2.0 | 2.2 |
| | 8.0 | 5.1 | 1.6 | 1.4 | 1.2 | 1.1 | 1.0 | 1.9 | 2.3 | 0.6 | 1.2 | 2.1 | 1.1 | 1.3 | 2.6 | 2.6 |
| | | 8.9 | 2.3 | 2.4 | 2.0 | 1.8 | 1.7 | 2.5 | 1.8 | 1.7 | 1.4 | 3.2 | 2.3 | 3.2 | 3.7 | 2.8 |
| | | 9.8 | 3.1 | 2.1 | 1.6 | 1.6 | 1.6 | 1.9 | 2.2 | 2.0 | 1.7 | 3.6 | 2.7 | 4.2 | 3.3 | 4.0 |
| | 9.5 | 12.2 | 6.7 | 4.7 | 4.5 | 4.2 | 4.8 | 4.1 | 3.8 | 2.3 | 3.8 | 3.1 | 3.9 | 4.9 | 5.3 | 8.7 |

(Continued)

Table 23 (Concluded)

| Test Wave | | | Wave Height, ft | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Direction deg | Period sec | Height ft | Gage 15 | Gage 16 | Gage 17 | Gage 18 | Gage 19 | Gage 20 | Gage 21 | Gage 22 | Gage 23 | Gage 24 | Gage 25 | Gage 26 | Gage 27 | Gage 28 | Gage 29 |
| | | | | | | | | +2.6 ft swl | | | | | | | | | |
| 326 | 6.0 | 5.6 | 1.4 | 1.2 | 1.0 | 0.2 | 0.5 | 0.8 | 0.8 | 0.5 | 0.5 | 0.2 | 1.0 | 1.5 | 0.5 | 2.3 | 5.9 |
| | 7.0 | 8.0 | 2.5 | 1.7 | 0.6 | 1.0 | 0.4 | 0.4 | 1.0 | 0.6 | 1.3 | 0.5 | 2.3 | 2.1 | 1.9 | 4.0 | 9.6 |
| | 8.0 | 5.5 | 1.9 | 2.0 | 0.5 | 0.5 | 0.4 | 0.2 | 0.2 | 0.4 | 0.5 | 0.5 | 0.6 | 2.0 | 1.9 | 2.0 | 8.4 |
| | | 10.3 | 2.6 | 3.1 | 1.6 | 1.4 | 1.1 | 1.6 | 0.8 | 1.3 | 2.2 | 2.0 | 2.7 | 3.2 | 3.4 | 4.8 | 14.3 |
| | 8.5 | 10.7 | 3.1 | 3.7 | 2.4 | 1.7 | 1.1 | 2.9 | 1.5 | 2.1 | 2.7 | 2.2 | 3.0 | 4.5 | 3.8 | 4.8 | 17.5 |
| | 9.0 | 6.2 | 2.3 | 2.8 | 0.6 | 0.4 | 1.0 | 1.5 | 0.9 | 1.0 | 0.9 | 0.8 | 1.3 | 1.4 | 1.6 | 3.1 | 9.8 |
| | | 11.9 | 3.7 | 4.5 | 2.9 | 2.2 | 2.9 | 4.1 | 3.2 | 2.8 | 1.8 | 4.1 | 3.6 | 4.8 | 4.1 | 5.1 | 17.6 |
| | 10.0 | 13.7 | 6.9 | 7.4 | 3.4 | 3.6 | 3.0 | 3.3 | 2.2 | 2.6 | 2.0 | 2.6 | 4.0 | 8.4 | 7.4 | 8.3 | 21.9 |
| 17 | 6.0 | 4.7 | 1.1 | 0.7 | 0.5 | 0.4 | 0.2 | 0.1 | 0.4 | <0.1 | 0.1 | <0.1 | 1.0 | 1.0 | 1.4 | 0.8 | 1.9 |
| | 7.0 | 7.3 | 2.1 | 2.8 | 1.3 | 1.3 | 0.2 | 0.4 | 0.3 | 0.2 | 0.6 | 0.3 | 0.6 | 1.9 | 2.5 | 2.2 | 2.8 |
| | 8.0 | 5.1 | 1.4 | 1.8 | 0.7 | 0.6 | 0.3 | 0.2 | 0.2 | 0.1 | 0.3 | 0.2 | 0.4 | 2.2 | 1.1 | 1.5 | 2.8 |
| | | 8.9 | 3.4 | 4.7 | 1.5 | 0.7 | 0.6 | 0.8 | 0.4 | 0.8 | 0.6 | 0.6 | 0.7 | 2.7 | 3.2 | 3.3 | 5.1 |
| | | 9.8 | 3.2 | 4.2 | 2.1 | 0.7 | 0.7 | 0.8 | 0.5 | 1.0 | 0.9 | 0.7 | 0.9 | 4.7 | 3.4 | 3.3 | 6.8 |
| | 9.5 | 12.2 | 6.9 | 7.0 | 2.9 | 1.6 | 1.6 | 1.6 | 1.8 | 1.3 | 0.7 | 1.3 | 1.7 | 11.1 | 5.4 | 6.5 | 9.5 |
| | | | | | | | | +4.8 ft swl | | | | | | | | | |
| 326 | 6.0 | 5.6 | 2.7 | 1.9 | 1.2 | 0.2 | 0.8 | 0.7 | 1.0 | 1.0 | 1.4 | 0.4 | 1.3 | 1.2 | 1.7 | 3.3 | 6.5 |
| | 7.0 | 8.0 | 2.0 | 3.0 | 1.7 | 1.3 | 0.9 | 0.8 | 1.9 | 1.2 | 1.4 | 0.6 | 1.9 | 2.8 | 2.3 | 4.4 | 12.8 |
| | 8.0 | 5.5 | 3.1 | 2.5 | 0.8 | 0.7 | 0.5 | 0.6 | 0.9 | 1.3 | 1.8 | 0.8 | 1.4 | 2.4 | 1.8 | 5.0 | 6.4 |
| | | 10.3 | 5.4 | 4.4 | 2.5 | 2.5 | 1.9 | 2.7 | 2.1 | 2.9 | 6.2 | 3.0 | 5.9 | 4.4 | 5.1 | 6.6 | 16.8 |
| | 8.5 | 10.7 | 5.0 | 4.9 | 2.3 | 2.7 | 3.2 | 2.7 | 3.5 | 4.7 | 5.4 | 3.7 | 3.6 | 6.8 | 6.0 | 7.7 | 20.6 |
| | 9.0 | 6.2 | 3.3 | 2.2 | 1.1 | 1.2 | 1.4 | 1.9 | 3.3 | 1.7 | 2.0 | 1.3 | 2.7 | 2.8 | 2.7 | 4.4 | 10.0 |
| | | 11.9 | 6.8 | 5.8 | 3.5 | 3.5 | 3.5 | 5.3 | 7.5 | 6.9 | 3.1 | 5.0 | 7.0 | 6.1 | 6.6 | 7.0 | 19.2 |
| | 10.0 | 13.7 | 9.5 | 10.5 | 6.9 | 5.8 | 2.8 | 7.3 | 3.5 | 5.6 | 4.2 | 5.2 | 6.4 | 10.1 | 8.1 | 10.0 | 23.6 |
| 17 | 6.0 | 4.7 | 1.8 | 1.6 | 0.2 | 0.7 | 0.3 | 0.2 | 0.5 | 0.4 | 0.2 | 0.3 | 1.1 | 2.3 | 0.8 | 2.9 | 3.0 |
| | 7.0 | 7.3 | 4.0 | 4.1 | 2.3 | 2.0 | 1.2 | 0.4 | 1.0 | 0.6 | 0.6 | 0.7 | 1.4 | 4.6 | 3.2 | 2.2 | 4.6 |
| | 8.0 | 5.1 | 3.1 | 4.2 | 3.0 | 1.5 | 0.8 | 0.8 | 0.3 | 0.9 | 0.4 | 0.8 | 0.8 | 1.3 | 2.2 | 2.1 | 3.7 |
| | | 8.9 | 3.5 | 7.6 | 3.3 | 2.1 | 1.5 | 1.3 | 0.7 | 0.9 | 2.7 | 1.8 | 2.7 | 3.1 | 4.4 | 5.1 | 6.0 |
| | | 9.8 | 4.6 | 7.3 | 3.0 | 2.4 | 1.4 | 1.3 | 0.8 | 1.2 | 2.8 | 1.6 | 2.4 | 6.2 | 5.1 | 6.0 | 7.2 |
| | 9.5 | 12.2 | 8.2 | 8.9 | 3.0 | 3.9 | 2.0 | 3.3 | 2.6 | 2.9 | 1.7 | 2.7 | 3.7 | 12.4 | 11.1 | 7.5 | 7.0 |

Table 24

Wave Heights for Severe-Weather Plans 6A-6C for Test Waves

from 17 and/or 279 deg, River Discharge 800 cfs

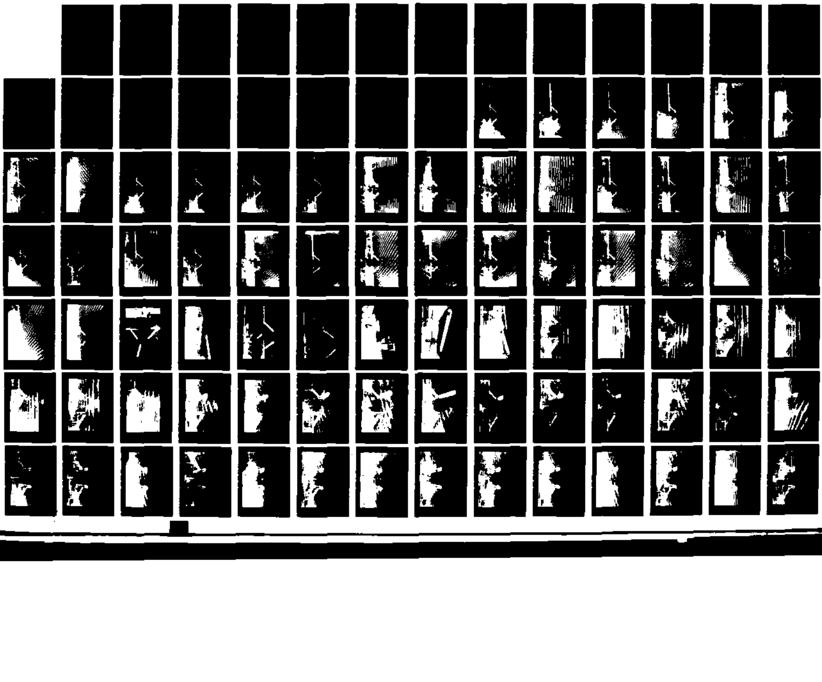
| Test Wave | | | Wave Height, ft | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Direction deg | Period sec | Height ft | Gage 1 | Gage 2 | Gage 3 | Gage 4 | Gage 5 | Gage 6 | Gage 7 | Gage 8 | Gage 9 | Gage 10 | Gage 11 | Gage 12 | Gage 13 | Gage 14 |
| | | | | | | | Plan 6A, +4.8 ft swl | | | | | | | | | |
| 17 | 7.0 | 7.3 | 1.0 | 1.1 | 0.8 | 0.4 | 0.9 | 1.6 | 1.6 | 0.8 | 1.0 | 1.0 | 1.5 | 1.5 | 0.9 | 2.5 |
| | 8.0 | 5.1 | 1.1 | 1.4 | 1.0 | 0.6 | 0.7 | 1.4 | 1.7 | 0.6 | 0.9 | 1.9 | 0.9 | 1.9 | 2.4 | 3.0 |
| | | | | | | | Plan 6B, +4.8 ft swl | | | | | | | | | |
| | 7.0 | 7.3 | 1.1 | 1.4 | 1.0 | 0.5 | 0.6 | 1.0 | 1.4 | 0.9 | 0.8 | 0.9 | 1.4 | 1.3 | 1.1 | 3.3 |
| | 8.0 | 5.1 | 0.7 | 0.5 | 0.6 | 0.3 | 0.6 | 1.1 | 1.4 | 0.3 | 1.0 | 1.6 | 0.8 | 1.3 | 1.7 | 1.8 |
| | | | | | | | Plan 6C, +4.8 ft swl | | | | | | | | | |
| | 7.0 | 7.3 | 1.5 | 1.2 | 1.5 | 1.5 | 1.3 | 2.6 | 1.5 | 1.5 | 1.0 | 2.1 | 0.9 | 3.2 | 1.9 | 2.2 |
| | 8.0 | 5.1 | 1.4 | 1.9 | 0.8 | 1.0 | 0.9 | 1.8 | 1.9 | 0.6 | 1.2 | 1.9 | 1.0 | 1.8 | 2.1 | 2.4 |
| 279 | 6.0 | 3.9 | 0.2 | 0.3 | 0.3 | 0.3 | 0.2 | 0.2 | 0.2 | 0.2 | 0.1 | 0.5 | 0.1 | 0.8 | 1.2 | 2.5 |
| | 7.0 | 5.5 | 0.2 | 0.7 | 0.2 | 0.8 | 0.3 | 0.3 | 0.8 | 0.7 | 1.1 | 1.5 | 0.6 | 1.7 | 1.5 | 3.8 |
| | 8.0 | 6.6 | 1.6 | 1.9 | 0.9 | 0.8 | 1.1 | 1.4 | 1.0 | 1.2 | 1.4 | 2.3 | 1.5 | 2.8 | 2.3 | 3.3 |
| | 9.0 | 4.3 | 1.6 | 2.2 | 0.5 | 0.9 | 0.4 | 0.2 | 0.4 | 1.3 | 0.5 | 1.2 | 1.8 | 1.3 | 2.0 | 1.7 |
| | | 8.1 | 4.6 | 2.6 | 2.8 | 2.8 | 2.0 | 1.3 | 2.0 | 3.1 | 1.2 | 3.0 | 4.5 | 3.0 | 4.2 | 6.4 |
| | | 8.6 | 5.2 | 3.2 | 2.5 | 3.0 | 1.5 | 1.7 | 2.4 | 2.6 | 1.8 | 3.4 | 4.4 | 3.0 | 4.5 | 7.9 |
| | 10.0 | 9.2 | 4.9 | 3.9 | 4.3 | 4.4 | 2.5 | 3.3 | 3.3 | 4.1 | 3.6 | 3.1 | 4.5 | 3.9 | 6.5 | 9.8 |
| | | | | | | | Plan 6C, +2.6 ft swl | | | | | | | | | |
| | 6.0 | 3.9 | 0.3 | <0.1 | 0.3 | 0.4 | 0.2 | 0.5 | 0.2 | 0.2 | 0.2 | 0.7 | 0.3 | 0.7 | 1.2 | 2.1 |
| | 7.0 | 5.5 | 0.4 | 0.5 | 0.2 | 0.6 | 0.3 | 0.2 | 0.7 | 0.4 | 0.1 | 1.0 | 0.4 | 0.9 | 1.6 | 1.9 |
| | 8.0 | 6.6 | 1.7 | 1.1 | 0.7 | 0.8 | 0.8 | 0.5 | 0.6 | 0.5 | 0.6 | 1.5 | 1.1 | 1.8 | 3.8 | 2.6 |
| | 9.0 | 4.3 | 1.0 | 0.5 | 0.7 | 0.9 | 0.4 | 0.7 | 0.4 | 1.3 | 0.3 | 0.6 | 0.9 | 1.0 | 1.5 | 2.5 |
| | | 8.1 | 2.0 | 1.5 | 1.9 | 1.2 | 1.5 | 1.1 | 1.3 | 2.2 | 1.2 | 1.6 | 2.8 | 2.8 | 3.9 | 5.0 |
| | | 8.6 | 1.9 | 1.6 | 2.5 | 1.7 | 1.8 | 1.3 | 1.4 | 3.0 | 1.6 | 2.1 | 3.0 | 3.2 | 4.5 | 6.6 |
| | 10.0 | 9.2 | 3.5 | 2.0 | 3.4 | 2.0 | 2.5 | 1.3 | 2.1 | 2.9 | 2.2 | 4.9 | 4.9 | 5.1 | 5.7 | 8.2 |

(Continued)

Table 24 (Concluded)

| Test Wave Direction deg | Test Wave Period sec | Test Wave Height ft | Wave Height, ft Gage 15 | Gage 16 | Gage 17 | Gage 18 | Gage 19 | Gage 20 | Gage 21 | Gage 22 | Gage 23 | Gage 24 | Gage 25 | Gage 26 | Gage 27 | Gage 28 | Gage 29 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | Plan 6A, +4.8 ft swl | | | | | | | | | | |
| 17 | 7.0 | 7.3 | 1.5 | 3.6 | 1.9 | 1.9 | 0.3 | 0.8 | 0.6 | 0.5 | 1.2 | 0.9 | 1.5 | 3.8 | 3.6 | 2.0 | 4.0 |
| | 8.0 | 5.1 | 1.7 | 3.3 | 2.5 | 1.6 | 0.9 | 1.0 | 0.3 | 0.9 | 0.6 | 1.1 | 1.1 | 1.5 | 3.1 | 2.3 | 2.7 |
| | | | | | | | Plan 6B, +4.8 ft swl | | | | | | | | | | |
| | 7.0 | 7.3 | 1.9 | 3.5 | 1.2 | 1.9 | 0.7 | 0.5 | 0.6 | 0.3 | 1.3 | 0.8 | 1.6 | 4.0 | 4.1 | 2.3 | 3.8 |
| | 8.0 | 5.1 | 1.6 | 2.2 | 2.4 | 1.3 | 0.7 | 0.8 | 0.3 | 0.8 | 0.4 | 0.9 | 0.8 | 1.3 | 1.8 | 2.7 | 3.8 |
| | | | | | | | Plan 6C, +4.8 ft swl | | | | | | | | | | |
| | 7.0 | 7.3 | 3.5 | 2.6 | 1.0 | 2.2 | 0.6 | 0.8 | 0.8 | 0.5 | 0.5 | 0.5 | 1.9 | 4.8 | 3.7 | 2.4 | 4.7 |
| | 8.0 | 5.1 | 2.4 | 2.9 | 2.5 | 1.7 | 0.7 | 1.0 | 0.3 | 0.7 | 0.6 | 1.1 | 0.9 | 1.4 | 3.1 | 1.5 | 3.9 |
| 279 | 6.0 | 3.9 | 1.1 | 3.1 | 0.9 | 1.7 | 1.3 | 0.8 | 0.9 | 0.5 | 0.5 | 0.3 | 1.1 | 5.9 | 4.4 | 4.7 | 3.1 |
| | 7.0 | 5.5 | 4.2 | 3.6 | 2.0 | 4.8 | 3.3 | 1.5 | 0.6 | 1.4 | 4.3 | 1.7 | 1.7 | 2.7 | 5.8 | 5.6 | 8.2 |
| | 8.0 | 6.6 | 5.7 | 7.2 | 3.6 | 1.8 | 1.9 | 2.6 | 0.8 | 1.8 | 1.6 | 2.0 | 2.4 | 4.7 | 11.8 | 4.9 | 6.6 |
| | 9.0 | 4.3 | 4.4 | 5.7 | 1.8 | 2.1 | 2.2 | 1.2 | 1.7 | 1.8 | 0.5 | 1.3 | 1.8 | 3.3 | 3.9 | 5.5 | 4.8 |
| | | 8.1 | 4.5 | 6.5 | 4.5 | 5.5 | 4.8 | 4.4 | 1.2 | 1.7 | 1.1 | 4.1 | 1.8 | 9.8 | 8.8 | 10.5 | 7.9 |
| | | 8.6 | 5.7 | 6.8 | 5.3 | 6.3 | 6.3 | 5.8 | 1.6 | 2.9 | 1.7 | 4.9 | 1.9 | 8.7 | 10.9 | 11.5 | 9.0 |
| | 10.0 | 8.2 | 5.9 | 7.6 | 6.0 | 6.5 | 3.6 | 7.7 | 2.2 | 5.6 | 3.3 | 6.7 | 4.1 | 11.8 | 13.1 | 15.7 | 7.8 |
| | | | | | | | Plan 6C, +2.6 ft swl | | | | | | | | | | |
| | 6.0 | 3.9 | 1.5 | 3.7 | 1.0 | 2.0 | 2.0 | 1.1 | 1.5 | 0.9 | 1.5 | 0.5 | 0.7 | 2.5 | 3.7 | 3.0 | 3.2 |
| | 7.0 | 5.5 | 3.1 | 3.1 | 1.9 | 3.6 | 1.6 | 0.4 | 1.8 | 1.5 | 5.0 | 2.1 | 1.4 | 5.8 | 6.1 | 4.1 | 5.4 |
| | 8.0 | 6.6 | 6.0 | 5.6 | 1.7 | 3.0 | 2.1 | 1.7 | 1.0 | 3.6 | 1.8 | 1.1 | 3.4 | 5.6 | 8.3 | 5.8 | 6.3 |
| | 9.0 | 4.3 | 4.0 | 2.7 | 1.5 | 0.6 | 1.9 | 3.1 | 2.1 | 1.0 | 0.4 | 0.8 | 1.8 | 4.1 | 4.9 | 4.9 | 4.0 |
| | | 8.1 | 6.8 | 6.1 | 3.0 | 3.0 | 3.7 | 3.0 | 2.1 | 2.9 | 0.9 | 2.6 | 3.4 | 8.0 | 6.5 | 7.9 | 9.4 |
| | | 8.6 | 5.5 | 8.7 | 3.1 | 3.7 | 4.4 | 5.0 | 2.5 | 2.4 | 1.0 | 2.4 | 3.8 | 8.5 | 8.4 | 9.2 | 10.2 |
| | 10.0 | 9.2 | 7.7 | 9.2 | 6.1 | 4.5 | 4.8 | 4.1 | 1.4 | 2.0 | 1.7 | 2.4 | 3.0 | 7.5 | 10.9 | 8.4 | 9.3 |

AD-A129 783 CLEVELAND HARBOR OHIO DESIGN FOR THE SAFE AND EFFICIENT 2/4
PASSAGE OF 1000-F..(U) ARMY ENGINEER WATERWAYS
EXPERIMENT STATION VICKSBURG MS HYDRA.. R R BOTTIN
UNCLASSIFIED MAR 83 WES/TR/HL-83-6 F/G 13/2 NL



1.0 2.8 2.5 3.2 2.2 3.6 4.0 2.0 1.1 1.8 1.25 1.4 1.6

MICROCOPY RESOLUTION TEST CHART
NATIONAL BUREAU OF STANDARDS 1963-A

Table 25

Wave Heights for Severe-Weather Plans 7 and 8 for Test Waves

from 279 deg, River Discharge 800 cfs

| | Test Wave | | Wave Height, ft | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Plan | Period sec | Height ft | Gage 1 | Gage 2 | Gage 3 | Gage 4 | Gage 5 | Gage 6 | Gage 7 | Gage 8 | Gage 9 | Gage 10 | Gage 11 | Gage 12 | Gage 13 | Gage 14 |
| | | | | | | | +2.6 ft swl | | | | | | | | | |
| 7 | 6.0 | 3.9 | 0.2 | 0.1 | 0.3 | 0.3 | <0.1 | 0.3 | 0.1 | 0.2 | 0.1 | 0.5 | 0.4 | 0.5 | 1.4 | 2.3 |
| | 7.0 | 5.5 | 0.5 | 0.5 | 0.7 | 0.8 | 0.4 | 0.5 | 0.4 | 0.3 | 0.5 | 1.2 | 0.5 | 0.7 | 0.8 | 2.2 |
| | 8.0 | 6.6 | 1.5 | 1.3 | 0.8 | 1.0 | 0.5 | 0.5 | 0.9 | 0.8 | 0.9 | 1.4 | 0.6 | 1.5 | 2.0 | 3.3 |
| | 9.0 | 4.3 | 0.4 | 0.8 | 0.3 | 0.7 | 0.4 | 0.6 | 0.7 | 0.6 | 0.4 | 0.5 | 0.7 | 0.8 | 1.7 | 3.4 |
| | | 8.1 | 2.0 | 1.6 | 1.9 | 1.4 | 0.9 | 1.1 | 1.8 | 2.1 | 1.1 | 1.6 | 2.5 | 2.1 | 4.3 | 5.3 |
| | | 8.6 | 2.5 | 1.7 | 2.4 | 1.3 | 1.3 | 1.5 | 1.9 | 2.3 | 1.4 | 2.1 | 2.6 | 2.4 | 5.5 | 5.0 |
| | 10.0 | 9.2 | 2.9 | 2.2 | 3.0 | 2.0 | 2.3 | 1.5 | 1.7 | 2.2 | 1.7 | 4.6 | 4.5 | 4.9 | 5.6 | 5.8 |
| 8 | 6.0 | 3.9 | 0.1 | 0.1 | 0.3 | 0.5 | <0.1 | 0.2 | 0.2 | 0.4 | 0.1 | 0.4 | 0.5 | 0.4 | 0.4 | 1.5 |
| | 7.0 | 5.5 | 0.6 | 0.4 | 0.5 | 0.8 | 0.1 | 0.3 | 0.5 | 0.3 | 0.5 | 0.7 | 0.4 | 0.5 | 0.6 | 2.0 |
| | 8.0 | 6.6 | 1.5 | 1.1 | 0.7 | 0.7 | 0.6 | 0.4 | 0.6 | 1.1 | 0.6 | 1.2 | 0.6 | 1.4 | 1.6 | 4.1 |
| | 9.0 | 4.3 | 0.4 | 0.5 | 1.0 | 0.8 | 0.5 | 0.5 | 0.7 | 0.8 | 0.4 | 0.7 | 1.1 | 1.1 | 2.1 | 3.4 |
| | | 8.1 | 1.9 | 1.5 | 1.9 | 1.5 | 1.3 | 1.0 | 1.7 | 2.4 | 0.9 | 1.4 | 2.7 | 2.1 | 4.3 | 5.0 |
| | | 8.6 | 2.3 | 1.9 | 2.6 | 2.2 | 1.4 | 1.1 | 1.9 | 3.3 | 1.8 | 2.0 | 2.5 | 2.6 | 4.2 | 6.0 |
| | 10.0 | 9.2 | 3.1 | 2.5 | 3.9 | 2.1 | 3.3 | 1.7 | 1.4 | 2.5 | 2.0 | 3.9 | 4.2 | 4.3 | 4.9 | 6.4 |
| | | | | | | | +4.8 ft swl | | | | | | | | | |
| 7 | 6.0 | 3.9 | 0.2 | 0.3 | 0.3 | 0.4 | 0.1 | 0.2 | 0.4 | 0.1 | 0.1 | 0.4 | 0.3 | 0.7 | 1.5 | 2.3 |
| | 7.0 | 5.5 | 0.3 | 0.5 | 0.3 | 0.7 | 0.3 | 0.4 | 0.5 | 0.5 | 1.0 | 1.3 | 0.4 | 1.3 | 1.8 | 4.4 |
| | 8.0 | 6.6 | 1.3 | 2.0 | 0.6 | 0.6 | 0.8 | 0.9 | 1.0 | 1.6 | 1.5 | 2.2 | 1.5 | 2.6 | 2.5 | 2.2 |
| | 9.0 | 4.3 | 1.5 | 2.2 | 0.5 | 0.9 | 0.4 | 0.3 | 0.7 | 1.2 | 0.5 | 1.2 | 1.7 | 1.3 | 1.8 | 1.6 |
| | | 8.1 | 4.0 | 2.9 | 3.4 | 2.7 | 1.5 | 1.8 | 2.0 | 2.9 | 1.3 | 2.2 | 4.5 | 3.9 | 4.2 | 6.1 |
| | | 8.6 | 5.1 | 3.0 | 2.6 | 2.8 | 1.8 | 1.9 | 2.2 | 2.8 | 1.6 | 3.0 | 4.7 | 3.9 | 4.7 | 6.5 |
| | 10.0 | 9.2 | 4.3 | 4.9 | 3.5 | 3.8 | 2.7 | 2.3 | 2.6 | 2.8 | 2.6 | 4.1 | 4.7 | 3.6 | 7.5 | 9.9 |

(Continued)

Table 25 (Concluded)

| Plan | Test Wave Period sec | Test Wave Height ft | Gage 15 | Gage 16 | Gage 17 | Gage 18 | Gage 19 | Gage 20 | Gage 21 | Gage 22 | Gage 23 | Gage 24 | Gage 25 | Gage 26 | Gage 27 | Gage 28 | Gage 29 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | +2.6 ft swl | | | | | | | | | |
| 7 | 6.0 | 3.9 | 1.4 | 3.7 | 0.7 | 2.1 | 1.9 | 1.0 | 1.0 | 0.7 | 1.4 | 0.5 | 0.9 | 3.4 | 3.3 | 2.7 | 4.1 |
| | 7.0 | 5.5 | 3.5 | 3.7 | 2.0 | 2.3 | 1.4 | 0.8 | 1.9 | 1.6 | 2.9 | 1.0 | 1.6 | 5.3 | 5.1 | 4.5 | 4.5 |
| | 8.0 | 6.6 | 4.3 | 7.0 | 1.6 | 2.5 | 1.4 | 1.7 | 0.7 | 2.1 | 1.4 | 1.9 | 2.2 | 4.5 | 5.0 | 6.7 | 7.0 |
| | 9.0 | 4.3 | 3.5 | 2.6 | 1.1 | 1.1 | 1.8 | 1.9 | 1.8 | 1.0 | 0.4 | 1.2 | 1.6 | 4.0 | 4.0 | 4.4 | 4.0 |
| | | 8.1 | 6.6 | 6.9 | 2.4 | 3.0 | 3.2 | 3.7 | 2.7 | 2.6 | 0.7 | 3.0 | 3.3 | 8.8 | 6.1 | 8.7 | 8.3 |
| | | 8.6 | 6.5 | 9.1 | 2.4 | 3.6 | 3.3 | 3.8 | 3.2 | 3.0 | 1.3 | 3.2 | 3.7 | 9.1 | 6.9 | 9.6 | 9.5 |
| | 10.0 | 9.2 | 7.0 | 7.3 | 5.7 | 4.1 | 4.8 | 3.2 | 3.2 | 3.0 | 2.0 | 2.7 | 2.8 | 6.8 | 9.4 | 8.8 | 9.4 |
| 8 | 6.0 | 3.9 | 1.8 | 3.5 | 0.5 | 1.5 | 1.0 | 0.8 | 1.4 | 0.7 | 1.2 | 0.4 | 0.6 | 3.4 | 3.0 | 3.2 | 3.7 |
| | 7.0 | 5.5 | 4.0 | 3.8 | 1.7 | 2.9 | 1.8 | 0.8 | 1.3 | 1.0 | 2.4 | 1.2 | 2.0 | 4.6 | 5.2 | 4.4 | 4.2 |
| | 8.0 | 6.6 | 4.4 | 5.8 | 2.2 | 2.6 | 1.6 | 2.7 | 0.6 | 0.9 | 1.0 | 1.3 | 1.4 | 6.1 | 5.9 | 5.9 | 4.8 |
| | 9.0 | 4.3 | 3.2 | 3.9 | 0.8 | 1.6 | 1.8 | 2.1 | 2.3 | 1.0 | 0.3 | 1.1 | 1.8 | 3.5 | 4.2 | 5.2 | 5.5 |
| | | 8.1 | 5.8 | 6.4 | 2.0 | 3.0 | 3.4 | 3.7 | 3.7 | 2.3 | 0.9 | 1.9 | 3.1 | 6.1 | 6.2 | 8.5 | 9.2 |
| | | 8.6 | 6.0 | 6.7 | 1.5 | 3.4 | 3.9 | 4.2 | 4.3 | 2.2 | 0.8 | 2.7 | 3.9 | 6.5 | 7.0 | 9.8 | 10.2 |
| | 10.0 | 9.2 | 6.0 | 8.0 | 6.0 | 3.9 | 4.5 | 3.8 | 2.3 | 3.0 | 1.7 | 2.0 | 2.5 | 6.5 | 7.8 | 9.2 | 8.9 |
| | | | | | | | | +4.8 ft swl | | | | | | | | | |
| 7 | 6.0 | 3.9 | 1.8 | 3.2 | 1.6 | 2.4 | 2.0 | 0.9 | 1.1 | 0.4 | 0.8 | 0.5 | 1.4 | 4.4 | 4.9 | 3.7 | 4.1 |
| | 7.0 | 5.5 | 5.2 | 5.0 | 2.4 | 4.9 | 3.3 | 1.1 | 0.4 | 1.4 | 5.0 | 2.1 | 2.3 | 4.3 | 5.8 | 4.2 | 5.2 |
| | 8.0 | 6.6 | 6.2 | 4.6 | 3.5 | 2.0 | 2.0 | 2.4 | 0.8 | 1.8 | 2.2 | 2.6 | 2.5 | 6.0 | 8.0 | 5.2 | 5.5 |
| | 9.0 | 4.3 | 4.6 | 5.4 | 1.8 | 2.2 | 2.2 | 1.3 | 1.4 | 1.6 | 0.7 | 1.2 | 1.7 | 3.7 | 4.4 | 5.6 | 4.4 |
| | | 8.1 | 5.2 | 5.1 | 5.5 | 5.6 | 5.2 | 4.5 | 1.3 | 2.0 | 1.0 | 4.3 | 1.8 | 8.6 | 7.6 | 9.6 | 8.5 |
| | | 8.6 | 5.5 | 5.8 | 5.4 | 6.0 | 5.7 | 5.0 | 1.4 | 3.9 | 2.3 | 5.0 | 2.2 | 8.6 | 8.2 | 10.2 | 8.3 |
| | 10.0 | 9.2 | 6.1 | 7.3 | 4.8 | 5.5 | 2.6 | 6.2 | 2.0 | 5.1 | 3.7 | 6.0 | 3.8 | 9.0 | 9.5 | 14.4 | 7.6 |

Table 26

Wave Heights for Severe-Weather Plans 8-9A for Test Waves

from 279 deg, +4.8 ft swl, River Discharge 800 cfs

| | Test Wave | | Wave Height, ft | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Plan | Period sec | Height ft | Gage 1 | Gage 2 | Gage 3 | Gage 4 | Gage 5 | Gage 6 | Gage 7 | Gage 8 | Gage 9 | Gage 10 | Gage 11 | Gage 12 | Gage 13 | Gage 14 |
| 8 | 6.0 | 3.9 | 0.2 | 0.2 | 0.2 | 0.3 | 0.2 | 0.2 | 0.3 | 0.1 | 0.3 | 0.2 | 0.4 | 0.7 | 0.4 | 1.5 |
| | 7.0 | 5.5 | 0.3 | 0.5 | 0.2 | 0.6 | 0.3 | 0.1 | 0.4 | 0.6 | 1.0 | 0.7 | 0.4 | 0.9 | 0.8 | 2.4 |
| | 8.0 | 6.6 | 1.3 | 1.8 | 0.9 | 0.9 | 0.7 | 0.5 | 0.9 | 0.8 | 0.9 | 1.7 | 1.3 | 2.2 | 1.5 | 4.4 |
| | 9.0 | 4.3 | 1.3 | 2.0 | 0.7 | 0.6 | 0.4 | 0.3 | 0.7 | 1.0 | 0.5 | 1.0 | 1.8 | 1.1 | 1.2 | 2.2 |
| | | 8.1 | 4.7 | 3.6 | 3.6 | 2.6 | 1.6 | 1.6 | 2.1 | 2.3 | 1.6 | 2.4 | 4.0 | 2.7 | 3.2 | 4.5 |
| | | 8.6 | 4.6 | 3.3 | 3.5 | 2.9 | 2.1 | 1.6 | 1.9 | 2.6 | 2.0 | 2.6 | 3.8 | 2.8 | 2.8 | 5.8 |
| | 10.0 | 9.2 | 4.5 | 2.7 | 3.7 | 3.0 | 2.6 | 2.1 | 3.3 | 4.6 | 2.7 | 4.0 | 3.9 | 3.1 | 4.3 | 5.9 |
| 9 | 6.0 | 3.9 | <0.1 | 0.4 | 0.2 | 0.4 | 0.1 | <0.1 | 0.2 | 0.3 | 0.3 | 0.3 | 0.6 | <0.1 | 0.7 | 2.4 |
| | 7.0 | 5.5 | 0.4 | 0.7 | 0.3 | 0.5 | 0.4 | 0.3 | 0.3 | 0.4 | 0.6 | 1.6 | 0.5 | 1.6 | 1.4 | 2.2 |
| | 8.0 | 6.6 | 0.7 | 1.6 | 0.8 | 0.6 | 0.8 | 0.4 | 1.4 | 1.4 | 0.9 | 1.9 | 1.6 | 2.2 | 2.7 | 2.7 |
| | 9.0 | 4.3 | 1.6 | 2.0 | 1.0 | 0.6 | 1.6 | 0.6 | 1.0 | 1.0 | 1.0 | 1.2 | 2.2 | 1.4 | 3.2 | 2.0 |
| | | 8.1 | 3.8 | 3.7 | 2.7 | 2.4 | 2.0 | 1.7 | 2.0 | 1.8 | 1.9 | 2.7 | 4.1 | 3.1 | 6.3 | 5.7 |
| | | 8.6 | 3.8 | 3.8 | 3.3 | 2.1 | 2.1 | 1.7 | 2.1 | 2.3 | 2.1 | 2.9 | 3.8 | 3.1 | 6.5 | 7.3 |
| | 10.0 | 9.2 | 3.7 | 3.4 | 2.3 | 3.8 | 2.1 | 2.1 | 2.1 | 3.6 | 2.5 | 4.2 | 3.7 | 3.3 | 6.9 | 7.4 |
| 9A | 6.0 | 3.9 | 0.1 | 0.1 | 0.3 | 0.3 | 0.2 | 0.2 | 0.2 | 0.2 | 0.4 | 0.3 | 0.4 | 0.1 | 0.8 | 0.8 |
| | 7.0 | 5.5 | 0.3 | 0.4 | 0.4 | 0.3 | 0.2 | 0.3 | 0.3 | 0.4 | 0.4 | 0.3 | 0.3 | 0.2 | 1.1 | 1.9 |
| | 8.0 | 6.6 | 0.9 | 0.8 | 1.1 | 0.6 | 0.6 | 0.5 | 0.8 | 0.6 | 0.5 | 1.2 | 1.1 | 1.6 | 1.6 | 3.6 |
| | 9.0 | 4.3 | 1.5 | 2.1 | 0.7 | 0.6 | 1.2 | 0.2 | 0.8 | 1.1 | 0.2 | 1.2 | 1.6 | 0.7 | 1.9 | 1.8 |
| | | 8.1 | 4.2 | 3.6 | 2.8 | 1.4 | 1.4 | 1.3 | 1.8 | 1.8 | 1.2 | 1.8 | 3.1 | 2.6 | 4.5 | 3.3 |
| | | 8.6 | 4.4 | 4.2 | 3.4 | 2.1 | 1.8 | 1.3 | 2.3 | 2.5 | 1.1 | 2.5 | 3.2 | 2.3 | 4.6 | 4.0 |
| | 10.0 | 9.2 | 5.9 | 3.1 | 3.1 | 3.6 | 2.0 | 2.1 | 2.8 | 3.4 | 2.3 | 3.8 | 3.9 | 3.2 | 4.3 | 5.2 |

(Continued)

Table 26 (Concluded)

| | Test Wave | | Wave Height, ft | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Plan | Period sec | Height ft | Gage 15 | Gage 16 | Gage 17 | Gage 18 | Gage 19 | Gage 20 | Gage 21 | Gage 22 | Gage 23 | Gage 24 | Gage 25 | Gage 26 | Gage 27 | Gage 28 | Gage 29 |
| 8 | 6.0 | 3.9 | 1.0 | 3.2 | 0.4 | 1.1 | 0.8 | 0.9 | 1.3 | 0.5 | 0.7 | 0.5 | 1.2 | 4.2 | 3.7 | 3.6 | 4.1 |
| | 7.0 | 5.5 | 4.3 | 4.2 | 1.7 | 3.6 | 2.4 | 0.3 | 1.6 | 1.1 | 3.1 | 1.6 | 1.2 | 4.3 | 4.7 | 4.4 | 5.7 |
| | 8.0 | 6.6 | 4.9 | 6.1 | 3.0 | 2.0 | 2.1 | 3.2 | 1.0 | 2.5 | 1.7 | 1.5 | 1.5 | 5.6 | 6.2 | 6.3 | 6.1 |
| | 9.0 | 4.3 | 3.5 | 4.0 | 1.5 | 2.3 | 2.8 | 2.6 | 1.1 | 1.6 | 0.6 | 0.5 | 1.3 | 3.9 | 3.8 | 5.1 | 5.0 |
| | | 8.1 | 6.1 | 6.8 | 5.3 | 5.1 | 5.2 | 4.1 | 2.7 | 3.4 | 1.2 | 3.7 | 1.6 | 7.0 | 6.4 | 9.0 | 9.3 |
| | | 8.6 | 6.6 | 7.3 | 4.6 | 5.8 | 5.8 | 5.0 | 2.5 | 3.9 | 2.1 | 4.2 | 1.9 | 7.9 | 7.5 | 9.9 | 9.7 |
| | 10.0 | 9.2 | 6.1 | 7.7 | 4.9 | 3.8 | 2.4 | 5.0 | 1.9 | 3.4 | 2.2 | 5.5 | 3.0 | 6.2 | 7.5 | 9.3 | 7.8 |
| 9 | 6.0 | 3.9 | 0.5 | 0.9 | 1.1 | 0.9 | 0.4 | 0.7 | 1.1 | 0.7 | 1.1 | 0.4 | 0.7 | 3.0 | 2.3 | 3.0 | 3.9 |
| | 7.0 | 5.5 | 1.6 | 2.6 | 1.7 | 1.5 | 1.3 | 1.7 | 2.1 | 2.1 | 2.5 | 1.0 | 0.2 | 3.7 | 4.4 | 4.9 | 4.8 |
| | 8.0 | 6.6 | 5.2 | 4.2 | 3.2 | 2.0 | 1.5 | 2.3 | 0.9 | 1.9 | 1.2 | 1.7 | 1.5 | 2.9 | 8.7 | 6.0 | 7.3 |
| | 9.0 | 4.3 | 4.6 | 3.9 | 1.7 | 2.0 | 2.1 | 1.5 | 1.0 | 1.4 | 0.4 | 1.1 | 0.9 | 3.9 | 2.5 | 3.3 | 2.7 |
| | | 8.1 | 4.8 | 4.4 | 4.2 | 4.3 | 4.2 | 4.1 | 1.6 | 1.8 | 1.4 | 4.9 | 2.4 | 10.7 | 7.2 | 8.2 | 7.6 |
| | | 8.6 | 5.6 | 4.6 | 3.9 | 4.7 | 4.4 | 4.3 | 1.6 | 2.0 | 1.8 | 4.7 | 1.8 | 11.5 | 7.6 | 8.5 | 7.9 |
| | 10.0 | 9.2 | 4.3 | 8.2 | 5.9 | 3.9 | 2.1 | 5.0 | 2.1 | 3.5 | 2.0 | 3.4 | 3.6 | 5.6 | 5.6 | 10.2 | 10.7 |
| 9A | 6.0 | 3.9 | 0.8 | 2.6 | 0.9 | 1.5 | 1.2 | 0.7 | 0.9 | 0.8 | 1.0 | 0.5 | 0.9 | 4.0 | 3.7 | 4.2 | 4.5 |
| | 7.0 | 5.5 | 3.4 | 2.7 | 1.2 | 2.2 | 2.0 | 0.3 | 1.6 | 1.4 | 2.5 | 0.5 | 1.2 | 3.9 | 4.8 | 5.3 | 6.7 |
| | 8.0 | 6.6 | 3.8 | 4.7 | 2.4 | 1.5 | 1.0 | 2.4 | 0.8 | 1.7 | 0.4 | 1.6 | 1.1 | 5.9 | 6.1 | 6.3 | 3.6 |
| | 9.0 | 4.3 | 2.9 | 3.0 | 1.2 | 1.5 | 1.9 | 1.8 | 0.7 | 1.1 | 0.5 | 0.6 | 0.8 | 3.5 | 4.0 | 4.7 | 3.4 |
| | | 8.1 | 4.9 | 5.6 | 3.8 | 4.3 | 4.0 | 3.1 | 1.9 | 2.2 | 1.4 | 4.4 | 1.3 | 5.8 | 7.6 | 8.8 | 6.6 |
| | | 8.6 | 5.7 | 5.7 | 3.2 | 4.3 | 4.2 | 3.5 | 2.3 | 2.1 | 1.9 | 4.6 | 1.3 | 6.4 | 8.1 | 10.4 | 8.1 |
| | 10.0 | 9.2 | 5.3 | 7.0 | 3.3 | 4.2 | 1.6 | 4.4 | 0.9 | 3.6 | 2.0 | 3.3 | 2.7 | 6.3 | 8.5 | 10.0 | 9.8 |

Table 27

Wave Heights for Severe-Weather Plans 10, 10A, and 11 for Test Waves

from 279 deg, River Discharge 800 cfs

| Plan | Test Wave Period sec | Test Wave Height ft | Gage 1 | Gage 2 | Gage 3 | Gage 4 | Gage 5 | Gage 6 | Gage 7 | Gage 8 | Gage 9 | Gage 10 | Gage 11 | Gage 12 | Gage 13 | Gage 14 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | +4.8 ft swl | | | | | | | | |
| 10 | 6.0 | 3.9 | 0.3 | 0.2 | 0.2 | 0.3 | 0.4 | 0.2 | 0.2 | 0.3 | 0.3 | 0.7 | 0.8 | 1.0 | 1.0 | 3.7 |
| | 7.0 | 5.5 | 0.5 | 0.4 | 0.7 | 0.7 | 0.2 | 0.5 | 0.5 | 0.6 | 0.3 | 1.9 | 0.3 | 2.2 | 1.9 | 3.7 |
| | 8.0 | 6.6 | 0.9 | 1.7 | 1.2 | 1.4 | 0.9 | 0.5 | 1.2 | 1.0 | 2.1 | 1.9 | 1.1 | 2.0 | 1.2 | 2.9 |
| | 9.0 | 4.3 | 0.8 | 1.3 | 1.2 | 0.4 | 0.2 | 0.2 | 0.9 | 1.1 | 0.3 | 0.8 | 1.0 | 0.9 | 1.8 | 2.8 |
| | | 8.1 | 3.8 | 2.2 | 3.9 | 2.4 | 1.3 | 1.6 | 1.9 | 2.0 | 1.7 | 1.6 | 2.0 | 2.2 | 3.6 | 6.7 |
| | | 8.6 | 4.2 | 2.7 | 3.1 | 2.5 | 2.0 | 1.9 | 2.3 | 2.7 | 2.6 | 2.0 | 1.9 | 2.0 | 3.7 | 7.8 |
| | 10.0 | 9.2 | 4.3 | 3.9 | 2.6 | 2.8 | 2.9 | 2.4 | 1.5 | 3.0 | 2.5 | 3.4 | 3.1 | 3.6 | 5.0 | 7.9 |
| 10A | 6.0 | 3.9 | 0.2 | 0.2 | 0.2 | 0.4 | 0.3 | <1.0 | 0.2 | 0.3 | 0.5 | 0.5 | 0.8 | 0.9 | 0.8 | 4.2 |
| | 7.0 | 5.5 | 0.5 | 0.3 | 0.8 | 0.6 | 0.3 | 0.4 | 0.5 | 0.6 | 0.2 | 2.1 | 0.3 | 2.5 | 2.3 | 4.2 |
| | 8.0 | 6.6 | 1.3 | 1.1 | 1.6 | 0.8 | 0.6 | 0.4 | 0.9 | 1.6 | 1.2 | 2.1 | 1.6 | 2.5 | 2.3 | 4.0 |
| | 9.0 | 4.3 | 0.7 | 0.7 | 1.4 | 1.2 | 0.3 | 0.3 | 0.9 | 0.6 | 0.5 | 1.2 | 0.6 | 1.0 | 0.7 | 2.7 |
| | | 8.1 | 3.8 | 2.7 | 4.0 | 2.6 | 1.9 | 1.2 | 1.5 | 1.7 | 1.5 | 1.7 | 2.5 | 2.9 | 3.9 | 6.5 |
| | | 8.6 | 4.9 | 3.4 | 3.1 | 1.6 | 2.1 | 1.5 | 1.8 | 2.7 | 1.6 | 1.4 | 3.0 | 3.4 | 4.4 | 5.5 |
| | 10.0 | 9.2 | 2.8 | 3.9 | 3.4 | 3.8 | 2.9 | 2.2 | 2.0 | 3.3 | 2.6 | 3.0 | 4.0 | 2.9 | 4.3 | 9.6 |
| 11 | 6.0 | 3.9 | 0.1 | 0.1 | 0.2 | 0.2 | <0.1 | 0.2 | 0.2 | 0.3 | 0.2 | <0.1 | <0.1 | 0.1 | 0.7 | 0.7 |
| | 7.0 | 5.5 | 0.4 | 0.2 | 0.3 | 0.4 | 0.2 | 0.3 | 0.1 | 0.4 | 0.3 | 0.9 | 0.2 | 0.8 | 1.1 | 0.6 |
| | 8.0 | 6.6 | 1.0 | 1.2 | 1.1 | 0.8 | 0.4 | 0.6 | 0.5 | 1.1 | 0.6 | 0.9 | 0.4 | 1.0 | 1.0 | 3.4 |
| | 9.0 | 4.3 | 0.6 | 1.1 | 1.2 | 0.3 | 0.5 | 0.2 | 0.7 | 0.5 | 0.6 | 0.5 | 0.7 | 0.3 | 1.0 | 1.0 |
| | | 8.1 | 3.3 | 2.1 | 3.6 | 2.1 | 1.5 | 1.7 | 2.6 | 1.3 | 1.9 | 1.0 | 2.4 | 1.5 | 1.9 | 1.7 |
| | | 8.6 | 3.2 | 2.3 | 3.6 | 1.8 | 2.1 | 1.9 | 2.2 | 3.4 | 2.5 | 1.5 | 3.2 | 1.7 | 2.9 | 2.2 |
| | 10.0 | 9.2 | 2.2 | 2.9 | 3.1 | 3.2 | 2.3 | 3.1 | 1.6 | 4.0 | 4.9 | 2.3 | 1.0 | 1.5 | 4.2 | 5.8 |
| | | | | | | | | +2.6 ft swl | | | | | | | | |
| | 6.0 | 3.9 | 0.2 | 0.1 | 0.5 | 0.4 | <0.1 | <0.1 | 0.2 | 0.3 | 0.3 | 0.3 | 0.4 | 0.1 | 0.9 | 0.9 |
| | 7.0 | 5.5 | 0.2 | 0.4 | 0.5 | 0.6 | 0.5 | 0.2 | 0.4 | 0.2 | 0.4 | 0.6 | 0.3 | 0.6 | 1.1 | 0.6 |
| | 8.0 | 6.6 | 1.1 | 0.9 | 0.9 | 1.2 | 0.7 | 0.7 | 0.4 | 0.5 | 0.8 | 0.7 | 0.2 | 0.7 | 0.6 | 1.6 |
| | 9.0 | 4.3 | 0.6 | 0.4 | 0.5 | 0.8 | 0.3 | 0.3 | 0.3 | 0.9 | 0.3 | 0.1 | 0.4 | 0.4 | 0.3 | 1.6 |
| | | 8.1 | 1.8 | 1.5 | 1.2 | 1.1 | 0.8 | 0.6 | 0.6 | 1.8 | 0.8 | 0.6 | 0.6 | 0.5 | 1.2 | 2.6 |
| | | 8.6 | 2.4 | 2.2 | 2.6 | 1.7 | 0.8 | 0.8 | 1.1 | 2.5 | 1.3 | 0.8 | 0.6 | 0.9 | 1.4 | 2.3 |
| | 10.0 | 9.2 | 2.2 | 2.5 | 2.4 | 2.2 | 1.9 | 2.0 | 1.2 | 2.2 | 1.7 | 1.9 | 1.6 | 1.8 | 3.1 | 4.7 |

(Continued)

Table 27 (Concluded)

| Plan | Test Wave Period sec | Test Wave Height ft | Gage 15 | Gage 16 | Gage 17 | Gage 18 | Gage 19 | Gage 20 | Gage 21 | Gage 22 | Gage 23 | Gage 24 | Gage 25 | Gage 26 | Gage 27 | Gage 28 | Gage 29 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | +4.8 ft swl | | | | | | | | | | |
| 10 | 6.0 | 3.9 | 2.4 | 2.3 | 1.7 | 3.1 | 2.2 | 0.6 | 2.8 | 0.8 | 1.4 | 0.5 | 0.6 | 1.9 | 1.6 | 4.6 | 4.9 |
| | 7.0 | 5.5 | 3.1 | 2.1 | 1.9 | 2.1 | 2.1 | 2.6 | 2.0 | 2.0 | 1.7 | 0.8 | 0.4 | 2.0 | 3.1 | 3.9 | 7.5 |
| | 8.0 | 6.6 | 2.5 | 5.2 | 2.9 | 1.2 | 0.9 | 3.9 | 1.2 | 2.0 | 1.0 | 0.7 | 0.7 | 1.8 | 3.4 | 5.3 | 7.2 |
| | 9.0 | 4.3 | 1.6 | 3.0 | 2.1 | 2.1 | 1.6 | 2.2 | 0.9 | 1.1 | 0.4 | 1.3 | 0.9 | 3.3 | 1.5 | 3.3 | 4.8 |
| | | 8.1 | 4.0 | 5.6 | 4.2 | 4.8 | 4.0 | 5.3 | 2.5 | 3.8 | 2.3 | 5.5 | 1.9 | 6.5 | 6.6 | 5.7 | 8.6 |
| | | 8.6 | 4.4 | 5.4 | 4.8 | 5.5 | 4.5 | 5.8 | 3.0 | 4.2 | 3.1 | 6.7 | 2.1 | 6.8 | 8.4 | 6.6 | 8.9 |
| | 10.0 | 9.2 | 7.6 | 6.5 | 4.8 | 4.3 | 3.1 | 6.6 | 1.7 | 5.5 | 3.3 | 6.4 | 4.5 | 3.6 | 10.4 | 8.4 | 9.4 |
| 10A | 6.0 | 3.9 | 2.5 | 1.3 | 1.9 | 3.3 | 2.3 | 0.9 | 2.5 | 1.0 | 1.4 | 0.7 | 0.8 | 1.0 | 2.0 | 3.9 | 4.1 |
| | 7.0 | 5.5 | 1.7 | 2.6 | 2.3 | 2.4 | 2.3 | 2.2 | 2.1 | 1.5 | 0.8 | 0.4 | 1.1 | 1.3 | 2.0 | 4.8 | 6.4 |
| | 8.0 | 6.6 | 2.7 | 3.9 | 3.4 | 1.4 | 1.1 | 4.5 | 1.4 | 2.7 | 0.8 | 1.5 | 1.1 | 3.1 | 3.0 | 5.5 | 7.1 |
| | 9.0 | 4.3 | 1.4 | 1.7 | 0.8 | 2.0 | 1.9 | 2.6 | 1.2 | 1.7 | 0.3 | 1.3 | 0.3 | 2.2 | 1.7 | 2.2 | 5.4 |
| | | 8.1 | 4.8 | 5.3 | 4.1 | 5.7 | 4.3 | 5.8 | 2.9 | 3.8 | 1.3 | 6.8 | 1.2 | 5.1 | 3.8 | 4.8 | 6.4 |
| | | 8.6 | 5.4 | 4.5 | 3.7 | 4.7 | 4.2 | 5.6 | 2.5 | 4.0 | 1.4 | 5.5 | 1.6 | 4.4 | 4.8 | 6.7 | 9.3 |
| | 10.0 | 9.2 | 6.9 | 5.3 | 4.7 | 4.5 | 3.1 | 6.9 | 1.9 | 7.3 | 2.3 | 7.1 | 4.8 | 4.8 | 7.7 | 6.9 | 9.3 |
| 11 | 6.0 | 3.9 | 0.8 | 1.8 | 0.7 | 1.8 | 1.0 | 0.6 | 1.1 | 0.5 | 0.6 | 0.5 | 0.7 | 0.9 | 0.3 | 2.7 | 5.6 |
| | 7.0 | 5.5 | 0.5 | 2.7 | 1.1 | 0.3 | 0.4 | 0.6 | 0.4 | 0.5 | 1.0 | 0.9 | 0.6 | 3.2 | 1.3 | 2.9 | 6.9 |
| | 8.0 | 6.6 | 2.4 | 2.7 | 1.1 | 1.8 | 0.6 | 3.2 | 0.7 | 2.0 | 0.9 | 1.3 | 0.9 | 3.3 | 3.8 | 5.9 | 7.6 |
| | 9.0 | 4.3 | 3.2 | 2.9 | 0.8 | 0.5 | 0.5 | 0.4 | 0.2 | 0.7 | 0.2 | 0.9 | 0.7 | 1.9 | 3.1 | 5.1 | 6.7 |
| | | 8.1 | 2.6 | 3.3 | 1.2 | 1.8 | 2.2 | 2.1 | 1.0 | 2.6 | 0.7 | 2.2 | 1.5 | 5.8 | 8.0 | 7.1 | 10.6 |
| | | 8.6 | 3.4 | 4.7 | 1.2 | 3.0 | 2.9 | 1.9 | 0.9 | 2.9 | 0.9 | 2.5 | 1.6 | 5.3 | 7.9 | 7.9 | 11.2 |
| | 10.0 | 9.2 | 4.8 | 6.5 | 3.9 | 3.4 | 1.6 | 4.1 | 2.5 | 5.0 | 1.7 | 4.9 | 3.0 | 4.1 | 8.5 | 11.3 | 13.2 |
| | | | | | | | +2.6 ft swl | | | | | | | | | | |
| | 6.0 | 3.9 | 0.5 | 0.8 | 0.6 | 1.1 | 0.6 | 0.4 | 1.0 | 0.4 | 0.9 | 0.5 | 0.5 | 1.5 | 1.2 | 2.2 | 4.9 |
| | 7.0 | 5.5 | 1.7 | 2.3 | 0.3 | 0.7 | 0.6 | 0.6 | 0.4 | 0.6 | 1.5 | 0.3 | 0.5 | 0.9 | 2.2 | 1.4 | 9.2 |
| | 8.0 | 6.6 | 1.9 | 1.6 | 0.5 | 0.7 | 0.4 | 0.9 | 0.3 | 0.9 | 0.5 | 0.6 | 0.8 | 2.1 | 1.6 | 4.6 | 10.1 |
| | 9.0 | 4.3 | 1.7 | 1.6 | 1.0 | 0.9 | 1.0 | 1.4 | 0.7 | 0.6 | 0.2 | 0.6 | 0.7 | 3.4 | 2.1 | 3.4 | 5.0 |
| | | 8.1 | 3.1 | 2.6 | 2.1 | 2.2 | 1.7 | 2.6 | 0.9 | 1.8 | 0.5 | 1.7 | 1.7 | 4.1 | 4.0 | 5.2 | 10.3 |
| | | 8.6 | 4.2 | 3.7 | 2.0 | 2.6 | 1.8 | 2.3 | 1.3 | 2.1 | 0.8 | 2.2 | 2.1 | 4.6 | 5.3 | 5.5 | 14.3 |
| | 10.0 | 9.2 | 2.4 | 5.1 | 4.4 | 2.6 | 2.8 | 3.5 | 1.7 | 1.9 | 1.9 | 2.9 | 1.7 | 4.8 | 8.1 | 9.3 | 13.2 |

Table 28

Wave Heights for Severe-Weather Plans 12-12B for Test Waves

from 279 deg, +4.8 ft swl, River Discharge 800 cfs

| | Test Wave | | Wave Height, ft | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Plan | Period sec | Height ft | Gage 1 | Gage 2 | Gage 3 | Gage 4 | Gage 5 | Gage 6 | Gage 7 | Gage 8 | Gage 9 | Gage 10 | Gage 11 | Gage 12 | Gage 13 | Gage 14 |
| 12 | 6.0 | 3.9 | 0.2 | 0.3 | 0.2 | 0.4 | 0.2 | 0.3 | 0.2 | 0.3 | 0.4 | 0.3 | 0.8 | 0.5 | 1.3 | 1.7 |
| | 7.0 | 5.5 | 0.5 | 0.7 | 0.7 | 0.4 | 0.4 | 0.1 | 0.4 | 0.4 | 0.3 | 1.1 | 0.5 | 1.0 | 2.0 | 4.7 |
| | 8.0 | 6.6 | 1.0 | 1.9 | 1.6 | 0.7 | 0.7 | 0.5 | 0.7 | 1.0 | 0.7 | 1.8 | 1.6 | 2.1 | 2.2 | 4.5 |
| | 9.0 | 4.3 | 0.8 | 0.8 | 1.6 | 0.4 | 0.9 | 0.7 | 0.8 | 0.8 | 0.8 | 0.9 | 1.7 | 1.3 | 2.0 | 2.4 |
| | | 8.1 | 3.8 | 2.3 | 2.6 | 1.8 | 1.7 | 1.8 | 1.7 | 1.3 | 1.6 | 2.0 | 2.2 | 2.3 | 4.9 | 5.6 |
| | | 8.6 | 3.8 | 2.9 | 3.5 | 2.1 | 2.0 | 2.2 | 1.7 | 2.7 | 2.0 | 1.6 | 1.9 | 1.8 | 4.3 | 5.9 |
| | 10.0 | 9.2 | 3.3 | 3.1 | 4.3 | 3.3 | 3.0 | 1.7 | 3.5 | 3.4 | 3.1 | 1.9 | 2.8 | 2.6 | 4.2 | 6.9 |
| 12A | 6.0 | 3.9 | 0.3 | 0.2 | 0.5 | 0.3 | 0.1 | 0.1 | 0.4 | 0.1 | 0.2 | 0.4 | 0.8 | 0.2 | 1.8 | 1.9 |
| | 7.0 | 5.5 | 0.2 | 0.5 | 0.3 | 0.5 | 0.2 | 0.5 | 0.4 | 0.2 | 0.4 | 1.1 | 0.3 | 1.1 | 1.5 | 3.9 |
| | 8.0 | 6.6 | 1.2 | 1.3 | 1.2 | 0.9 | 0.3 | 0.4 | 0.6 | 1.8 | 1.0 | 1.4 | 1.4 | 1.4 | 1.9 | 4.5 |
| | 9.0 | 4.3 | 0.7 | 0.7 | 1.6 | 0.3 | 0.9 | 0.4 | 0.4 | 0.7 | 0.7 | 0.6 | 1.2 | 1.0 | 2.2 | 2.3 |
| | | 8.1 | 4.3 | 3.1 | 3.1 | 2.0 | 1.4 | 1.8 | 1.4 | 2.1 | 1.2 | 1.4 | 2.8 | 2.9 | 6.2 | 4.7 |
| | | 8.6 | 3.3 | 4.2 | 4.2 | 1.8 | 3.0 | 1.8 | 1.1 | 2.5 | 2.3 | 1.3 | 2.2 | 1.5 | 4.9 | 5.7 |
| | 10.0 | 9.2 | 3.4 | 2.9 | 3.6 | 3.4 | 2.7 | 2.7 | 2.4 | 3.6 | 3.8 | 2.6 | 1.9 | 2.0 | 3.5 | 7.5 |
| 12B | 6.0 | 3.9 | 0.1 | 0.2 | 0.2 | 0.4 | <1.0 | 0.2 | 0.2 | 0.2 | 0.3 | 0.2 | 0.4 | 0.4 | 0.8 | 1.6 |
| | 7.0 | 5.5 | 0.4 | 0.3 | 0.5 | 0.5 | 0.2 | 0.3 | 0.5 | 0.4 | 0.1 | 0.3 | 0.3 | 0.4 | 0.7 | 2.3 |
| | 8.0 | 6.6 | 0.9 | 1.7 | 1.3 | 0.8 | 0.5 | 0.5 | 0.3 | 1.2 | 0.8 | 0.5 | 1.1 | 0.8 | 1.6 | 2.5 |
| | 9.0 | 4.3 | 0.7 | 0.4 | 1.3 | 0.3 | 0.8 | 0.3 | 0.3 | 0.6 | 0.5 | 0.6 | 1.1 | 0.8 | 1.9 | 0.8 |
| | | 8.1 | 3.9 | 3.6 | 2.9 | 2.1 | 1.0 | 1.7 | 2.1 | 2.3 | 1.3 | 0.9 | 1.9 | 1.5 | 4.4 | 2.7 |
| | | 8.6 | 3.6 | 3.8 | 3.3 | 1.9 | 2.3 | 1.4 | 1.3 | 2.2 | 1.7 | 1.1 | 1.4 | 1.1 | 2.9 | 3.2 |
| | 10.0 | 9.2 | 3.2 | 2.7 | 2.7 | 2.8 | 2.5 | 2.2 | 2.6 | 3.0 | 3.2 | 1.2 | 1.8 | 1.7 | 2.5 | 4.7 |

(Continued)

Table 28 (Concluded)

| Plan | Test Wave Period sec | Test Wave Height ft | Gage 15 | Gage 16 | Gage 17 | Gage 18 | Gage 19 | Gage 20 | Gage 21 | Gage 22 | Gage 23 | Gage 24 | Gage 25 | Gage 26 | Gage 27 | Gage 28 | Gage 29 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 12 | 6.0 | 3.9 | 2.4 | 2.4 | 1.8 | 0.9 | 1.1 | 0.5 | 1.8 | 2.1 | 2.9 | 0.5 | 0.5 | 1.1 | 1.6 | 2.9 | 4.9 |
| | 7.0 | 5.5 | 3.5 | 1.8 | 2.4 | 1.4 | 2.0 | 1.8 | 2.7 | 3.2 | 5.3 | 1.4 | 0.4 | 2.7 | 4.0 | 4.4 | 7.1 |
| | 8.0 | 6.6 | 1.9 | 1.2 | 4.0 | 1.9 | 1.7 | 4.2 | 0.6 | 2.3 | 0.5 | 1.6 | 1.9 | 5.0 | 3.2 | 5.1 | 7.7 |
| | 9.0 | 4.3 | 1.7 | 1.7 | 0.9 | 1.9 | 1.5 | 2.0 | 0.5 | 1.2 | 0.4 | 0.9 | 0.7 | 5.5 | 4.1 | 2.1 | 8.9 |
| | | 8.1 | 1.8 | 2.6 | 3.8 | 4.2 | 2.8 | 4.1 | 2.1 | 3.2 | 1.4 | 5.2 | 2.8 | 4.2 | 5.6 | 10.8 | 12.1 |
| | | 8.6 | 3.5 | 3.6 | 3.1 | 5.3 | 3.7 | 4.6 | 3.5 | 4.1 | 1.9 | 5.9 | 4.0 | 3.8 | 6.1 | 10.4 | 13.1 |
| | 10.0 | 9.2 | 5.5 | 4.6 | 3.3 | 2.8 | 1.6 | 4.1 | 3.2 | 6.3 | 2.5 | 5.7 | 4.1 | 10.8 | 6.4 | 8.1 | 14.2 |
| 12A | 6.0 | 3.9 | 1.4 | 1.4 | 1.3 | 1.1 | 0.8 | 0.9 | 1.6 | 1.2 | 2.3 | 0.4 | 0.8 | 1.1 | 2.8 | 2.4 | 4.6 |
| | 7.0 | 5.5 | 3.1 | 2.0 | 2.2 | 1.1 | 1.9 | 2.2 | 3.0 | 2.6 | 3.4 | 0.8 | 0.6 | 2.8 | 2.5 | 4.8 | 7.8 |
| | 8.0 | 6.6 | 1.3 | 2.0 | 3.2 | 2.3 | 1.7 | 4.2 | 1.1 | 2.3 | 0.8 | 1.3 | 1.5 | 5.8 | 2.1 | 4.9 | 9.5 |
| | 9.0 | 4.3 | 1.1 | 1.7 | 0.6 | 2.2 | 1.9 | 1.9 | 0.4 | 1.0 | 0.3 | 1.1 | 1.0 | 4.3 | 4.3 | 2.8 | 7.8 |
| | | 8.1 | 2.8 | 2.8 | 3.9 | 5.9 | 4.1 | 5.1 | 2.3 | 2.6 | 2.0 | 5.9 | 4.1 | 5.6 | 6.5 | 7.1 | 11.9 |
| | | 8.6 | 2.4 | 2.5 | 2.7 | 6.3 | 4.4 | 5.7 | 2.1 | 4.0 | 1.4 | 6.2 | 4.3 | 5.4 | 7.3 | 9.3 | 15.0 |
| | 10.0 | 9.2 | 6.2 | 5.6 | 2.9 | 2.6 | 1.7 | 4.1 | 2.8 | 6.3 | 2.4 | 6.4 | 3.3 | 8.2 | 5.6 | 4.7 | 16.3 |
| 12B | 6.0 | 3.9 | 1.5 | 1.3 | 0.3 | 1.5 | 1.1 | 0.7 | 1.4 | 0.5 | 1.1 | 0.5 | 0.6 | 0.9 | 2.0 | 2.5 | 5.0 |
| | 7.0 | 5.5 | 3.1 | 1.6 | 1.6 | 1.2 | 1.5 | 1.1 | 1.9 | 1.4 | 1.7 | 1.1 | 1.1 | 3.2 | 3.0 | 4.3 | 8.3 |
| | 8.0 | 6.6 | 1.1 | 1.8 | 2.0 | 1.2 | 0.9 | 2.4 | 0.4 | 1.3 | 0.6 | 1.3 | 0.7 | 5.1 | 2.7 | 4.4 | 8.0 |
| | 9.0 | 4.3 | 1.5 | 2.1 | 0.5 | 1.9 | 1.4 | 1.2 | 0.2 | 0.6 | 0.3 | 0.6 | 0.5 | 4.7 | 4.5 | 3.4 | 7.0 |
| | | 8.1 | 2.7 | 2.0 | 2.6 | 3.7 | 2.9 | 3.4 | 1.1 | 1.7 | 1.5 | 3.5 | 1.7 | 5.3 | 6.0 | 7.2 | 11.3 |
| | | 8.6 | 2.5 | 3.1 | 1.6 | 4.2 | 3.4 | 3.9 | 1.1 | 2.4 | 1.3 | 4.5 | 2.3 | 4.8 | 7.1 | 8.8 | 14.6 |
| | 10.0 | 9.2 | 5.0 | 6.1 | 2.1 | 1.9 | 1.1 | 3.3 | 2.1 | 3.7 | 2.2 | 4.9 | 2.1 | 8.9 | 4.8 | 5.2 | 16.0 |

Table 29

Wave Heights for Severe-Weather Plans 12C-12E for Test Waves from 279 deg, River Discharge 800 cfs

| | Test Wave | | Wave Height, ft | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Plan | Period sec | Height ft | Gage 1 | Gage 2 | Gage 3 | Gage 4 | Gage 5 | Gage 6 | Gage 7 | Gage 8 | Gage 9 | Gage 10 | Gage 11 | Gage 12 | Gage 13 | Gage 14 |
| | | | | | | | | +4.8 ft swl | | | | | | | | |
| 12C | 6.0 | 3.9 | 0.1 | 0.1 | 0.3 | 0.4 | 0.1 | 0.2 | 0.3 | 0.5 | 0.2 | 0.3 | 0.5 | 0.4 | 1.2 | 2.0 |
| | 7.0 | 5.5 | 0.4 | 0.2 | 0.4 | 0.5 | 0.2 | 0.3 | 0.5 | 0.5 | 0.4 | 0.5 | 0.4 | 0.6 | 1.2 | 2.3 |
| | 8.0 | 6.6 | 0.7 | 1.5 | 1.1 | 0.7 | 0.7 | 0.7 | 0.7 | 1.1 | 0.7 | 0.5 | 1.1 | 0.5 | 1.8 | 2.5 |
| | 9.0 | 4.3 | 0.4 | 1.2 | 1.5 | 0.4 | 0.6 | 0.6 | 0.4 | 0.6 | 0.6 | 0.7 | 1.3 | 0.8 | 1.8 | 1.4 |
| | | 8.1 | 3.0 | 3.3 | 2.5 | 1.6 | 1.2 | 1.7 | 2.0 | 1.8 | 1.2 | 0.8 | 1.6 | 1.6 | 4.3 | 3.3 |
| | | 8.6 | 2.9 | 3.5 | 2.6 | 1.8 | 1.2 | 2.3 | 2.3 | 2.6 | 1.7 | 1.1 | 1.2 | 1.3 | 4.1 | 3.8 |
| | 10.0 | 9.2 | 3.6 | 2.6 | 3.5 | 3.7 | 3.4 | 1.9 | 3.8 | 2.6 | 3.2 | 3.0 | 3.5 | 2.3 | 3.5 | 6.5 |
| 12D | 6.0 | 3.9 | 0.2 | 0.2 | 0.3 | 0.3 | 0.2 | 0.1 | 0.2 | <0.1 | <0.1 | 0.1 | 0.4 | 0.4 | 0.6 | 0.5 |
| | 7.0 | 5.5 | 0.3 | 0.2 | 0.4 | 0.5 | 0.2 | 0.3 | 0.4 | 0.5 | 0.3 | 0.3 | 0.6 | 0.4 | 1.0 | 2.0 |
| | 8.0 | 6.6 | 0.9 | 1.3 | 1.3 | 1.0 | 1.0 | 0.6 | 0.9 | 1.3 | 0.7 | 0.7 | 0.9 | 0.6 | 1.2 | 2.6 |
| | 9.0 | 4.3 | 0.8 | 0.9 | 1.2 | 0.3 | 0.7 | 0.5 | 0.3 | 0.8 | 0.5 | 0.7 | 0.6 | 0.8 | 1.2 | 1.1 |
| | | 8.1 | 3.5 | 2.7 | 2.4 | 1.9 | 1.1 | 1.6 | 1.9 | 1.5 | 1.3 | 1.0 | 1.7 | 2.2 | 3.5 | 2.2 |
| | | 8.6 | 3.6 | 3.0 | 3.3 | 2.1 | 2.1 | 1.7 | 2.1 | 2.2 | 1.7 | 1.2 | 1.0 | 1.3 | 2.5 | 2.7 |
| | 10.0 | 9.2 | 3.8 | 3.0 | 3.8 | 3.1 | 2.7 | 2.2 | 3.3 | 3.4 | 3.2 | 2.1 | 3.0 | 2.2 | 3.4 | 3.9 |
| 12E | 6.0 | 3.9 | <0.1 | 0.3 | 0.2 | 0.3 | <0.1 | 0.3 | 0.2 | 0.3 | 0.2 | 0.4 | 0.3 | 0.6 | 0.4 | 1.0 |
| | 7.0 | 5.5 | 0.2 | 0.5 | 0.6 | 0.3 | 0.3 | 0.5 | 0.3 | 0.3 | 0.3 | 0.2 | 0.3 | 0.2 | 1.0 | 2.3 |
| | 8.0 | 6.6 | 0.9 | 1.8 | 1.5 | 1.0 | 0.5 | 0.8 | 0.5 | 1.3 | 0.7 | 0.6 | 1.2 | 0.9 | 1.5 | 2.1 |
| | 9.0 | 4.3 | 0.7 | 0.5 | 1.4 | 0.3 | 0.7 | 0.3 | 0.3 | 0.6 | 0.4 | 0.6 | 0.9 | 0.7 | 1.6 | 0.8 |
| | | 8.1 | 5.1 | 3.3 | 2.9 | 1.8 | 1.3 | 1.7 | 1.8 | 1.6 | 1.4 | 0.9 | 1.9 | 1.3 | 3.9 | 2.4 |
| | | 8.6 | 4.1 | 3.3 | 3.4 | 2.1 | 1.6 | 1.3 | 1.9 | 2.6 | 1.8 | 1.3 | 1.3 | 1.9 | 1.9 | 3.6 |
| | 10.0 | 9.2 | 2.9 | 3.0 | 3.7 | 2.8 | 3.2 | 3.0 | 2.9 | 3.8 | 2.8 | 1.7 | 1.6 | 1.8 | 2.2 | 3.8 |
| | | | | | | | | +2.6 ft swl | | | | | | | | |
| 12C | 6.0 | 3.9 | 0.3 | 0.2 | 0.4 | 0.4 | 0.2 | 0.3 | 0.2 | 0.4 | 0.2 | 0.2 | 0.2 | 0.4 | 0.5 | 1.0 |
| | 7.0 | 5.5 | 0.1 | 0.4 | 0.7 | 0.7 | 0.2 | 0.4 | 0.6 | 0.1 | 0.2 | 0.5 | 0.2 | 0.4 | 1.0 | 1.7 |
| | 8.0 | 6.6 | 1.0 | 0.7 | 0.6 | 1.0 | 0.6 | 0.4 | 0.2 | 0.6 | 0.7 | 0.7 | 0.2 | 0.8 | 1.5 | 2.5 |
| | 9.0 | 4.3 | 0.5 | 0.5 | 0.6 | 0.7 | 0.3 | 0.2 | 0.3 | 0.7 | 0.3 | 0.2 | 0.5 | 0.5 | 0.6 | 0.4 |
| | | 8.1 | 1.9 | 1.6 | 1.6 | 1.1 | 0.9 | 0.7 | 0.7 | 1.9 | 1.2 | 0.7 | 1.6 | 1.3 | 2.0 | 2.4 |
| | | 8.6 | 2.0 | 2.0 | 2.6 | 1.8 | 1.0 | 0.9 | 1.2 | 2.9 | 1.7 | 0.8 | 1.1 | 1.5 | 1.9 | 2.4 |
| | 10.0 | 9.2 | 2.0 | 2.2 | 2.6 | 2.5 | 1.7 | 1.4 | 1.8 | 2.0 | 1.8 | 0.7 | 1.0 | 1.6 | 2.5 | 2.7 |

(Continued)

Table 29 (Concluded)

| Plan | Test Wave Period sec | Test Wave Height ft | Gage 15 | Gage 16 | Gage 17 | Gage 18 | Gage 19 | Gage 20 | Gage 21 | Gage 22 | Gage 23 | Gage 24 | Gage 25 | Gage 26 | Gage 27 | Gage 28 | Gage 29 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | +4.8 ft swl | | | | | | | | | | |
| 12C | 6.0 | 3.9 | 2.4 | 0.5 | 0.7 | 1.7 | 1.0 | 0.9 | 0.7 | 0.6 | 1.3 | 0.2 | 0.2 | 0.6 | 3.1 | 3.0 | 4.7 |
| | 7.0 | 5.5 | 2.7 | 1.0 | 1.6 | 1.0 | 1.4 | 0.9 | 1.7 | 1.2 | 1.2 | 0.5 | 0.8 | 4.5 | 4.6 | 4.5 | 9.1 |
| | 8.0 | 6.6 | 1.2 | 2.4 | 2.6 | 1.3 | 0.8 | 2.4 | 0.3 | 1.2 | 0.4 | 0.7 | 0.8 | 5.3 | 1.9 | 5.8 | 9.2 |
| | 9.0 | 4.3 | 1.9 | 2.1 | 0.5 | 1.3 | 1.3 | 1.0 | 0.6 | 0.7 | 0.4 | 0.5 | 0.5 | 6.1 | 3.8 | 2.4 | 8.1 |
| | | 8.1 | 2.3 | 2.8 | 3.0 | 3.2 | 2.5 | 2.8 | 1.1 | 1.8 | 1.0 | 3.1 | 2.0 | 4.7 | 5.4 | 8.0 | 12.0 |
| | | 8.6 | 3.6 | 3.5 | 2.4 | 3.3 | 2.8 | 2.8 | 1.3 | 2.0 | 1.5 | 3.4 | 2.2 | 2.4 | 6.5 | 10.6 | 14.3 |
| | 10.0 | 9.2 | 4.5 | 4.2 | 2.2 | 3.4 | 1.6 | 3.4 | 1.9 | 3.4 | 1.8 | 3.9 | 2.4 | 9.2 | 6.1 | 5.3 | 13.5 |
| 12D | 6.0 | 3.9 | 3.1 | 1.6 | 0.6 | 1.3 | 1.0 | 0.8 | 1.5 | 0.8 | 1.0 | 0.5 | 0.9 | 0.9 | 4.7 | 2.4 | 5.1 |
| | 7.0 | 5.5 | 3.0 | 1.1 | 1.3 | 0.9 | 1.4 | 0.7 | 1.6 | 1.3 | 1.2 | 0.7 | 0.9 | 4.7 | 6.2 | 4.9 | 8.1 |
| | 8.0 | 6.6 | 1.4 | 2.7 | 2.4 | 1.4 | 1.1 | 2.2 | 0.5 | 1.6 | 0.2 | 1.1 | 0.8 | 7.1 | 2.0 | 6.0 | 9.3 |
| | 9.0 | 4.3 | 1.5 | 1.6 | 1.3 | 1.8 | 1.6 | 1.2 | 0.5 | 0.7 | 0.4 | 0.7 | 0.4 | 4.5 | 2.1 | 2.2 | 6.0 |
| | | 8.1 | 2.2 | 2.9 | 2.3 | 2.3 | 1.8 | 1.9 | 0.8 | 1.8 | 0.7 | 3.1 | 1.5 | 5.2 | 5.1 | 9.3 | 11.8 |
| | | 8.6 | 3.3 | 3.5 | 2.2 | 2.4 | 1.6 | 2.0 | 1.6 | 2.7 | 1.0 | 3.6 | 1.1 | 3.6 | 5.6 | 10.4 | 13.7 |
| | 10.0 | 9.2 | 5.3 | 4.1 | 2.1 | 2.0 | 1.1 | 2.0 | 1.6 | 2.8 | 1.5 | 3.3 | 1.8 | 7.5 | 6.9 | 7.0 | 14.3 |
| 12E | 6.0 | 3.9 | 2.3 | 2.1 | 0.5 | 1.0 | 0.9 | 0.1 | 1.1 | 0.5 | 1.3 | 0.2 | 0.6 | 2.9 | 2.6 | 3.0 | 4.0 |
| | 7.0 | 5.5 | 2.8 | 2.4 | 2.0 | 0.9 | 1.2 | 0.5 | 1.0 | 1.2 | 2.4 | 1.3 | 1.0 | 3.0 | 4.1 | 4.1 | 5.4 |
| | 8.0 | 6.6 | 2.5 | 1.4 | 2.5 | 1.2 | 0.8 | 2.6 | 0.6 | 2.0 | 0.6 | 1.2 | 0.9 | 5.0 | 3.9 | 4.8 | 8.1 |
| | 9.0 | 4.3 | 1.8 | 1.8 | 0.7 | 1.8 | 1.4 | 1.0 | 0.3 | 0.6 | 0.2 | 0.6 | 0.5 | 4.2 | 3.4 | 3.7 | 6.1 |
| | | 8.1 | 2.9 | 1.5 | 2.0 | 3.0 | 2.5 | 2.5 | 0.8 | 1.6 | <0.1 | 3.2 | 1.3 | 4.8 | 4.9 | 7.1 | 10.2 |
| | | 8.6 | 2.4 | 5.5 | 2.5 | 3.3 | 2.5 | 2.5 | 1.2 | 2.0 | 0.7 | 3.3 | 2.1 | 4.5 | 4.1 | 9.1 | 13.8 |
| | 10.0 | 9.2 | 4.6 | 4.4 | 2.0 | 1.6 | 0.9 | 2.5 | 1.4 | 3.2 | 1.8 | 2.9 | 1.7 | 6.7 | 5.3 | 7.4 | 15.2 |
| | | | | | | | +2.6 ft swl | | | | | | | | | | |
| 12C | 6.0 | 3.9 | 0.5 | 0.6 | 0.8 | 1.0 | 0.6 | 0.4 | 0.8 | 0.5 | 0.8 | 0.2 | 0.2 | 1.4 | 1.5 | 2.0 | 2.1 |
| | 7.0 | 5.5 | 1.4 | 2.1 | 1.1 | 0.9 | 0.8 | 0.6 | 0.8 | 1.0 | 1.3 | 0.9 | 0.9 | 2.3 | 2.3 | 1.2 | 6.4 |
| | 8.0 | 6.6 | 1.3 | 1.2 | 1.2 | 0.6 | 0.7 | 0.9 | 0.2 | 1.0 | 0.7 | 0.7 | 0.4 | 1.5 | 5.3 | 3.5 | 6.2 |
| | 9.0 | 4.3 | 0.5 | 1.7 | 0.4 | 0.9 | 0.7 | 0.6 | 0.4 | 0.5 | 0.2 | 0.4 | 0.7 | 3.9 | 2.1 | 2.8 | 4.8 |
| | | 8.1 | 3.2 | 2.7 | 1.6 | 1.4 | 1.1 | 1.7 | 1.3 | 1.0 | 0.6 | 1.3 | 0.6 | 5.1 | 5.3 | 8.5 | 10.0 |
| | | 8.6 | 2.6 | 4.5 | 1.6 | 1.4 | 1.1 | 1.6 | 1.2 | 1.0 | 0.6 | 1.3 | 0.9 | 4.3 | 6.8 | 6.1 | 11.4 |
| | 10.0 | 9.2 | 3.0 | 5.2 | 3.4 | 1.6 | 1.3 | 1.8 | 2.1 | 1.3 | 0.8 | 1.9 | 1.4 | 4.4 | 5.0 | 10.8 | 14.5 |

Table 30

Wave Heights for Severe-Weather Plans 13-13D for Test Waves

from 279 deg, +4.8 ft swl, River Discharge 800 cfs

| | Test Wave | | Wave Height, ft | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Plan | Period sec | Height ft | Gage 1 | Gage 2 | Gage 3 | Gage 4 | Gage 5 | Gage 6 | Gage 7 | Gage 8 | Gage 9 |
| 13 | 6.0 | 3.9 | 0.2 | 0.2 | 0.4 | 0.3 | 0.2 | <0.1 | 0.2 | 0.1 | 0.2 |
| | 7.0 | 5.5 | 0.4 | 0.4 | 0.4 | 0.4 | 0.2 | 0.3 | 0.4 | 0.3 | 0.5 |
| | 8.0 | 6.6 | 0.9 | 1.1 | 1.1 | 1.0 | 0.6 | 0.8 | 1.0 | 1.2 | 0.5 |
| | 9.0 | 4.3 | 0.8 | 0.8 | 1.4 | 0.2 | 0.7 | 0.4 | 0.8 | 0.7 | 0.6 |
| | | 8.1 | 2.5 | 2.8 | 2.7 | 2.2 | 1.4 | 1.4 | 1.7 | 1.7 | 1.3 |
| | | 8.6 | 3.2 | 3.1 | 3.3 | 2.0 | 2.3 | 1.3 | 1.8 | 2.2 | 2.0 |
| | 10.0 | 9.2 | 2.7 | 2.7 | 4.1 | 3.4 | 2.7 | 2.2 | 3.3 | 2.4 | 3.2 |
| 13A | 6.0 | 3.9 | 0.3 | 0.2 | 0.4 | 0.3 | 0.2 | 0.2 | 0.4 | 0.3 | 0.1 |
| | 7.0 | 5.5 | 0.5 | 0.3 | 0.5 | 0.4 | 0.3 | 0.2 | 0.2 | 0.4 | 0.3 |
| | 8.0 | 6.6 | 1.3 | 1.0 | 1.5 | 0.8 | 0.6 | 0.5 | 0.5 | 1.1 | 1.0 |
| | 9.0 | 4.3 | 0.8 | 1.0 | 1.1 | 0.4 | 0.6 | 0.3 | 1.0 | 0.7 | 0.8 |
| | | 8.1 | 3.6 | 2.7 | 3.1 | 2.1 | 1.5 | 1.5 | 1.4 | 1.9 | 1.8 |
| | | 8.6 | 2.9 | 2.2 | 4.4 | 2.6 | 2.5 | 1.3 | 1.3 | 2.5 | 1.8 |
| | 10.0 | 9.2 | 3.1 | 2.9 | 4.8 | 3.6 | 3.4 | 2.0 | 2.3 | 2.5 | 3.4 |
| 13B | 6.0 | 3.9 | 0.2 | 0.3 | 0.4 | 0.3 | 0.2 | 0.2 | 0.2 | 0.1 | 0.2 |
| | 7.0 | 5.5 | 0.2 | 0.3 | 0.5 | 0.3 | 0.1 | 0.5 | 0.2 | 0.3 | 0.3 |
| | 8.0 | 6.6 | 0.9 | 1.5 | 1.4 | 0.7 | 0.5 | 0.6 | 0.4 | 1.1 | 0.4 |
| | 9.0 | 4.3 | 0.9 | 0.8 | 1.3 | 0.4 | 0.6 | 0.5 | 0.4 | 0.6 | 0.6 |
| | | 8.1 | 3.3 | 3.2 | 2.2 | 1.4 | 1.2 | 1.4 | 1.3 | 1.7 | 1.4 |
| | | 8.6 | 4.2 | 2.8 | 3.3 | 1.9 | 2.0 | 1.5 | 1.9 | 1.7 | 2.6 |
| | 10.0 | 9.2 | 4.1 | 3.4 | 3.4 | 3.2 | 1.9 | 1.9 | 1.4 | 2.4 | 1.8 |
| 13C | 6.0 | 3.9 | 0.2 | 0.4 | 0.3 | 0.4 | 0.3 | 0.3 | 0.2 | 0.2 | 0.2 |
| | 7.0 | 5.5 | 0.3 | 0.4 | 0.6 | 0.4 | 0.4 | 0.2 | 0.1 | 0.4 | 0.4 |
| | 8.0 | 6.6 | 1.2 | 1.0 | 1.8 | 0.8 | 0.5 | 0.4 | 0.4 | 0.9 | 0.9 |
| | 9.0 | 4.3 | 1.1 | 1.1 | 1.4 | 0.4 | 0.7 | 0.3 | 0.7 | 0.9 | 0.5 |
| | | 8.1 | 3.0 | 2.5 | 1.9 | 1.5 | 1.2 | 1.7 | 1.1 | 1.7 | 1.6 |
| | | 8.6 | 2.7 | 2.8 | 3.2 | 1.9 | 1.6 | 2.2 | 2.1 | 2.6 | 2.1 |
| | 10.0 | 9.2 | 3.3 | 2.8 | 4.0 | 3.1 | 3.3 | 1.7 | 2.1 | 2.4 | 2.6 |
| 13D | 6.0 | 3.9 | 0.2 | 0.4 | 0.2 | 0.3 | <0.1 | 0.2 | 0.2 | 0.2 | 0.3 |
| | 7.0 | 5.5 | 0.5 | 0.6 | 0.3 | 0.5 | 0.3 | 0.2 | 0.6 | 0.4 | 0.7 |
| | 8.0 | 6.6 | 0.7 | 1.0 | 1.3 | 0.8 | 0.6 | 0.9 | 0.7 | 1.1 | 0.4 |
| | 9.0 | 4.3 | 0.7 | 0.9 | 1.2 | 0.2 | 0.7 | 0.5 | 0.6 | 0.5 | 0.7 |
| | | 8.1 | 2.2 | 3.1 | 3.6 | 1.6 | 1.2 | 1.4 | 2.2 | 1.7 | 1.7 |
| | | 8.6 | 3.0 | 2.6 | 3.2 | 2.1 | 1.5 | 1.4 | 2.0 | 2.2 | 2.2 |
| | 10.0 | 9.2 | 3.0 | 3.1 | 3.0 | 2.8 | 2.4 | 2.5 | 2.8 | 2.7 | 3.2 |

(Continued)

Table 30 (Continued)

| Test Wave | | | Wave Height, ft | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Plan | Period sec | Height ft | Gage 10 | Gage 11 | Gage 12 | Gage 13 | Gage 14 | Gage 15 | Gage 16 | Gage 17 | Gage 18 | Gage 19 |
| 13 | 6.0 | 3.9 | 0.2 | 0.3 | 0.1 | 0.7 | 2.3 | 2.7 | 1.9 | 0.7 | 2.7 | 1.9 |
| | 7.0 | 5.5 | 1.1 | 0.4 | 1.4 | 1.2 | 2.8 | 3.1 | 3.1 | 1.8 | 0.5 | 1.1 |
| | 8.0 | 6.6 | 1.1 | 1.5 | 1.5 | 2.0 | 3.0 | 3.1 | 3.8 | 3.6 | 1.4 | 0.8 |
| | 9.0 | 4.3 | 0.5 | 0.7 | 0.4 | 1.4 | 1.7 | 1.4 | 2.1 | 1.0 | 1.3 | 1.1 |
| | | 8.1 | 1.0 | 1.4 | 1.5 | 3.8 | 5.7 | 4.5 | 4.3 | 3.1 | 5.2 | 4.6 |
| | | 8.6 | 1.8 | 1.7 | 2.2 | 2.9 | 6.1 | 7.0 | 4.9 | 2.3 | 6.4 | 5.2 |
| | 10.0 | 9.2 | 2.3 | 3.7 | 3.0 | 2.9 | 6.2 | 7.3 | 5.3 | 2.6 | 5.4 | 2.9 |
| 13A | 6.0 | 3.9 | 0.7 | 0.4 | 0.3 | 1.8 | 1.7 | 2.5 | 1.5 | 1.5 | 1.9 | 1.2 |
| | 7.0 | 5.5 | 1.5 | 0.3 | 1.6 | 0.7 | 3.1 | 2.9 | 4.3 | 0.9 | 0.4 | 1.1 |
| | 8.0 | 6.6 | 1.7 | 1.3 | 1.7 | 1.1 | 3.0 | 4.4 | 3.5 | 2.7 | 1.6 | 0.7 |
| | 9.0 | 4.3 | 0.1 | 0.4 | 0.3 | 0.7 | 2.6 | 1.5 | 3.1 | 0.7 | 1.7 | 1.8 |
| | | 8.1 | 1.3 | 2.3 | 2.1 | 3.1 | 4.2 | 5.3 | 4.9 | 2.5 | 4.0 | 3.5 |
| | | 8.6 | 1.4 | 1.9 | 1.5 | 3.5 | 4.5 | 6.0 | 5.1 | 3.0 | 4.2 | 4.1 |
| | 10.0 | 9.2 | 2.1 | 2.5 | 2.4 | 3.7 | 6.0 | 7.1 | 4.0 | 3.6 | 4.1 | 3.0 |
| 13B | 6.0 | 3.9 | 0.5 | 0.2 | 0.1 | 0.8 | 1.8 | 2.4 | 2.0 | 1.2 | 1.6 | 0.9 |
| | 7.0 | 5.5 | 1.1 | 0.2 | 1.1 | 0.8 | 2.0 | 2.5 | 2.6 | 1.4 | 0.4 | 0.9 |
| | 8.0 | 6.6 | 1.3 | 1.4 | 1.3 | 0.8 | 2.4 | 3.6 | 3.2 | 3.2 | 1.2 | 0.7 |
| | 9.0 | 4.3 | 0.3 | 0.6 | 0.5 | 0.7 | 2.2 | 1.5 | 2.1 | 0.6 | 1.6 | 1.5 |
| | | 8.1 | 0.7 | 2.0 | 2.0 | 3.3 | 3.8 | 4.8 | 5.5 | 3.1 | 4.1 | 4.1 |
| | | 8.6 | 1.2 | 2.2 | 1.8 | 3.8 | 4.4 | 5.4 | 5.9 | 3.2 | 4.7 | 5.2 |
| | 10.0 | 9.2 | 2.1 | 2.2 | 2.0 | 3.6 | 4.7 | 4.8 | 3.7 | 2.4 | 3.9 | 1.8 |
| 13C | 6.0 | 3.9 | 0.2 | 0.3 | 0.2 | 0.7 | 1.3 | 1.8 | 0.9 | 1.1 | 0.8 | 0.4 |
| | 7.0 | 5.5 | 1.2 | 0.3 | 1.1 | 0.5 | 1.9 | 1.7 | 2.7 | 0.7 | 0.3 | 0.8 |
| | 8.0 | 6.6 | 1.5 | 1.0 | 1.3 | 0.9 | 2.2 | 3.9 | 2.6 | 1.7 | 1.1 | 0.7 |
| | 9.0 | 4.3 | 0.2 | 0.4 | 0.6 | 1.0 | 2.1 | 1.6 | 2.4 | 0.8 | 1.9 | 1.6 |
| | | 8.1 | 1.3 | 2.3 | 2.1 | 2.6 | 3.3 | 4.7 | 5.2 | 2.6 | 3.1 | 3.7 |
| | | 8.6 | 1.4 | 1.9 | 1.2 | 2.8 | 3.8 | 4.9 | 6.5 | 2.6 | 3.1 | 3.4 |
| | 10.0 | 9.2 | 2.0 | 2.1 | 2.1 | 4.0 | 5.7 | 5.8 | 5.8 | 3.8 | 2.9 | 1.8 |
| 13D | 6.0 | 3.9 | 0.3 | 0.2 | 0.2 | 1.8 | 1.8 | 2.0 | 1.4 | 1.5 | 0.9 | 0.8 |
| | 7.0 | 5.5 | 0.7 | 0.1 | 0.9 | 1.3 | 1.9 | 3.0 | 2.2 | 1.4 | 0.5 | 0.5 |
| | 8.0 | 6.6 | 0.6 | 1.2 | 0.9 | 1.5 | 2.2 | 2.9 | 1.7 | 3.1 | 0.8 | 0.5 |
| | 9.0 | 4.3 | 0.3 | 0.7 | 0.5 | 0.7 | 1.7 | 0.8 | 1.7 | 0.6 | 0.4 | 0.5 |
| | | 8.1 | 0.9 | 1.6 | 1.6 | 3.9 | 4.4 | 4.4 | 3.3 | 3.5 | 5.1 | 4.3 |
| | | 8.6 | 1.3 | 1.6 | 2.0 | 3.4 | 5.7 | 4.2 | 4.0 | 2.1 | 6.1 | 4.9 |
| | 10.0 | 9.2 | 2.5 | 4.1 | 2.6 | 2.6 | 6.5 | 6.9 | 5.3 | 2.6 | 5.2 | 3.3 |

(Continued)

Table 30 (Concluded)

| Test Wave | | | Wave Height, ft | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Plan | Period sec | Height ft | Gage 20 | Gage 21 | Gage 22 | Gage 23 | Gage 24 | Gage 25 | Gage 26 | Gage 27 | Gage 28 | Gage 29 |
| 13 | 6.0 | 3.9 | 0.9 | 2.3 | 1.5 | 2.2 | 0.5 | 0.7 | 1.5 | 0.6 | 3.5 | 4.0 |
| | 7.0 | 5.5 | 1.3 | 2.3 | 1.9 | 1.8 | 1.2 | 0.8 | 3.7 | 4.1 | 4.0 | 6.9 |
| | 8.0 | 6.6 | 3.0 | 0.8 | 2.8 | 0.5 | 1.1 | 0.8 | 3.4 | 3.8 | 5.6 | 5.7 |
| | 9.0 | 4.3 | 1.2 | 0.7 | 0.9 | 0.3 | 0.7 | 0.6 | 5.3 | 1.8 | 3.0 | 4.1 |
| | | 8.1 | 4.9 | 1.7 | 3.3 | 1.4 | 3.2 | 2.3 | 2.6 | 6.1 | 6.7 | 10.5 |
| | | 8.6 | 5.9 | 2.2 | 4.5 | 1.3 | 4.6 | 3.2 | 4.4 | 5.5 | 7.2 | 10.9 |
| | 10.0 | 9.2 | 6.4 | 1.9 | 6.2 | 1.8 | 5.2 | 4.1 | 5.8 | 2.6 | 7.2 | 12.6 |
| 13A | 6.0 | 3.9 | 0.6 | 1.7 | 1.2 | 2.2 | 0.1 | 0.5 | 0.4 | 1.7 | 3.7 | 4.0 |
| | 7.0 | 5.5 | 1.4 | 2.0 | 1.7 | 1.8 | 1.3 | 0.8 | 3.3 | 4.5 | 3.5 | 7.2 |
| | 8.0 | 6.6 | 3.4 | 0.9 | 2.9 | 0.6 | 1.1 | 0.5 | 4.5 | 2.7 | 5.9 | 7.2 |
| | 9.0 | 4.3 | 1.9 | 0.6 | 1.7 | 0.4 | 0.7 | 0.6 | 5.1 | 2.3 | 2.8 | 6.8 |
| | | 8.1 | 4.8 | 2.9 | 4.0 | 1.5 | 3.9 | 1.9 | 4.6 | 2.7 | 5.3 | 9.0 |
| | | 8.6 | 4.6 | 2.8 | 4.4 | 1.4 | 4.0 | 2.6 | 5.0 | 5.1 | 6.9 | 10.8 |
| | 10.0 | 9.2 | 4.8 | 1.8 | 6.8 | 1.9 | 6.4 | 4.2 | 4.7 | 5.8 | 4.6 | 11.8 |
| 13B | 6.0 | 3.9 | 0.9 | 1.8 | 1.1 | 1.6 | 0.2 | 0.5 | 0.6 | 1.4 | 3.1 | 3.3 |
| | 7.0 | 5.5 | 1.0 | 2.1 | 1.4 | 1.9 | 0.7 | 0.6 | 1.6 | 1.2 | 2.7 | 5.3 |
| | 8.0 | 6.6 | 3.4 | 0.9 | 2.5 | 0.9 | 1.2 | 0.6 | 2.5 | 2.8 | 3.7 | 7.0 |
| | 9.0 | 4.3 | 1.6 | 0.8 | 1.5 | 0.4 | 0.7 | 0.7 | 1.7 | 2.4 | 1.6 | 4.6 |
| | | 8.1 | 3.8 | 2.5 | 3.4 | 1.3 | 2.3 | 1.9 | 2.4 | 4.2 | 6.0 | 8.4 |
| | | 8.6 | 4.6 | 2.8 | 4.3 | 1.7 | 4.3 | 2.5 | 1.8 | 4.1 | 5.6 | 11.4 |
| | 10.0 | 9.2 | 4.7 | 1.3 | 4.4 | 1.8 | 4.1 | 2.8 | 3.3 | 2.9 | 4.1 | 11.3 |
| 13C | 6.0 | 3.9 | 0.4 | 0.7 | 0.8 | 1.3 | 0.3 | 0.3 | 2.1 | 2.1 | 3.4 | 2.8 |
| | 7.0 | 5.5 | 1.0 | 1.2 | 1.2 | 1.2 | 0.9 | 0.8 | 2.1 | 4.1 | 4.0 | 5.0 |
| | 8.0 | 6.6 | 2.4 | 0.6 | 2.0 | 0.7 | 0.8 | 0.6 | 4.0 | 2.2 | 5.8 | 4.8 |
| | 9.0 | 4.3 | 1.6 | 0.6 | 1.5 | 0.4 | 0.8 | 0.8 | 4.9 | 1.7 | 3.1 | 3.7 |
| | | 8.1 | 4.0 | 2.5 | 3.0 | 1.6 | 3.4 | 2.0 | 4.8 | 6.6 | 5.4 | 7.0 |
| | | 8.6 | 3.4 | 2.2 | 3.2 | 1.5 | 3.6 | 2.3 | 7.7 | 5.2 | 5.5 | 7.8 |
| | 10.0 | 9.2 | 4.2 | 1.8 | 5.7 | 1.6 | 5.3 | 3.3 | 4.4 | 4.4 | 7.2 | 9.0 |
| 13D | 6.0 | 3.9 | 0.6 | 2.2 | 1.2 | 1.6 | 0.2 | 0.6 | 1.7 | 2.0 | 2.4 | 4.0 |
| | 7.0 | 5.5 | 0.7 | 2.1 | 1.9 | 2.6 | 0.9 | 0.8 | 3.7 | 4.5 | 4.5 | 6.5 |
| | 8.0 | 6.6 | 1.4 | 0.7 | 1.8 | 0.9 | 1.0 | 0.8 | 2.7 | 1.9 | 5.8 | 5.8 |
| | 9.0 | 4.3 | 0.9 | 0.5 | 1.2 | 0.3 | 0.9 | 0.9 | 4.4 | 0.9 | 2.7 | 4.7 |
| | | 8.1 | 3.4 | 1.3 | 2.3 | 1.3 | 2.2 | 1.1 | 3.9 | 5.6 | 4.4 | 7.5 |
| | | 8.6 | 5.1 | 1.4 | 3.0 | 1.5 | 3.4 | 1.6 | 5.2 | 5.3 | 5.3 | 9.7 |
| | 10.0 | 9.2 | 6.5 | 2.1 | 6.1 | 1.9 | 3.9 | 3.4 | 4.2 | 3.8 | 7.5 | 11.1 |

Table 31

Wave Heights for Severe-Weather Plans 13D, 14, 14A, and 15 for Test Waves from 279 deg, +2.6 ft swl, River Discharge 800 cfs

| | Test Wave | | Wave Height, ft | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Plan | Period sec | Height ft | Gage 1 | Gage 2 | Gage 3 | Gage 4 | Gage 5 | Gage 6 | Gage 7 | Gage 8 | Gage 9 | Gage 10 | Gage 11 | Gage 12 | Gage 13 | Gage 14 |
| 13D | 6.0 | 3.9 | 0.2 | 0.3 | 0.5 | 0.3 | 0.1 | 0.1 | 0.1 | 0.2 | 0.2 | 0.4 | 0.2 | 0.2 | 0.5 | 2.0 |
| | 7.0 | 5.5 | 0.2 | 0.5 | 0.7 | 0.7 | 0.2 | 0.3 | 0.2 | 0.1 | 0.2 | 1.0 | 0.3 | 1.0 | 1.1 | 1.6 |
| | 8.0 | 6.6 | 0.8 | 0.6 | 0.5 | 0.8 | 0.4 | 0.4 | 0.4 | 0.4 | 0.6 | 0.8 | 0.8 | 1.3 | 1.4 | 1.7 |
| | 9.0 | 4.3 | 0.5 | 0.4 | 0.8 | 0.4 | 0.3 | 0.3 | 0.2 | 0.6 | 0.3 | 0.3 | 0.4 | 0.4 | 0.4 | 1.3 |
| | | 8.1 | 1.5 | 1.4 | 1.0 | 1.1 | 1.0 | 0.7 | 1.1 | 1.5 | 0.8 | 1.0 | 1.4 | 1.3 | 3.5 | 3.4 |
| | | 8.6 | 1.9 | 2.1 | 2.0 | 1.7 | 0.7 | 1.1 | 1.4 | 2.1 | 1.5 | 1.2 | 1.3 | 1.8 | 3.7 | 3.6 |
| | 10.0 | 9.2 | 2.2 | 2.1 | 2.7 | 1.8 | 1.6 | 1.2 | 1.4 | 1.7 | 1.9 | 1.6 | 1.6 | 2.2 | 3.5 | 4.7 |
| 14 | 6.0 | 3.9 | 0.1 | 0.3 | 0.2 | 0.3 | 0.1 | 0.2 | 0.2 | 0.3 | 0.2 | 0.3 | 0.1 | 0.3 | 0.9 | 1.7 |
| | 7.0 | 5.5 | 0.2 | 0.6 | 0.6 | 0.8 | 0.3 | 0.5 | 0.4 | 0.3 | <0.1 | 0.8 | 0.2 | 0.7 | 1.2 | 2.5 |
| | 8.0 | 6.6 | 0.9 | 0.7 | 0.6 | 0.9 | 0.4 | 0.6 | 0.2 | 0.6 | 0.6 | 0.9 | 0.9 | 1.8 | 1.8 | 2.4 |
| | 9.0 | 4.3 | 0.7 | 1.0 | 0.3 | 0.6 | 0.3 | 0.2 | 0.4 | 1.0 | 0.4 | 0.4 | 0.5 | 0.4 | 0.8 | 1.2 |
| | | 8.1 | 1.8 | 1.3 | 1.3 | 1.0 | 0.9 | 0.9 | 0.9 | 2.1 | 1.0 | 1.1 | 1.8 | 1.2 | 3.4 | 2.8 |
| | | 8.6 | 1.9 | 1.6 | 1.8 | 1.4 | 0.8 | 1.4 | 1.8 | 2.9 | 1.5 | 1.6 | 1.4 | 1.7 | 2.9 | 2.7 |
| | 10.0 | 9.2 | 2.2 | 2.1 | 2.5 | 2.6 | 2.0 | 1.7 | 2.0 | 2.2 | 2.0 | 2.1 | 1.8 | 2.7 | 3.1 | 4.8 |
| 14A | 6.0 | 3.9 | <0.1 | 0.2 | 0.2 | 0.3 | 0.2 | 0.2 | <0.1 | 0.3 | 0.2 | 0.2 | 0.2 | 0.3 | 0.4 | 2.3 |
| | 7.0 | 5.5 | 0.2 | 0.4 | 0.7 | 0.8 | 0.2 | 0.5 | 0.4 | 0.2 | 0.2 | 0.8 | 0.2 | 0.8 | 0.7 | 2.1 |
| | 8.0 | 6.6 | 0.9 | 0.5 | 0.6 | 0.9 | 0.4 | 0.5 | 0.3 | 0.7 | 0.6 | 0.9 | 0.8 | 1.2 | 1.6 | 2.7 |
| | 9.0 | 4.3 | 0.3 | 0.4 | 0.7 | 0.5 | 0.3 | 0.3 | 0.3 | 0.3 | 0.2 | 0.3 | 0.4 | 0.4 | 0.8 | 1.3 |
| | | 8.1 | 1.6 | 1.1 | 1.7 | 1.3 | 0.9 | 1.0 | 0.9 | 2.1 | 1.0 | 1.0 | 1.0 | 1.[illegible] | 3.0 | 3.7 |
| | | 8.6 | 2.4 | 1.5 | 1.8 | 1.7 | 0.6 | 1.3 | 1.5 | 2.2 | 1.6 | 1.2 | 1.1 | 1.[illegible] | 2.7 | 3.4 |
| | 10.0 | 9.2 | 1.8 | 1.5 | 2.3 | 2.7 | 1.8 | 1.5 | 1.7 | 2.4 | 1.9 | 1.7 | 2.0 | 2.0 | 2.6 | 3.7 |
| 15 | 6.0 | 3.9 | 0.2 | 0.2 | 0.4 | 0.3 | <0.1 | 0.1 | <0.1 | 0.2 | 0.1 | 0.3 | 0.1 | <0.1 | 0.2 | 0.6 |
| | 7.0 | 5.5 | 0.3 | 0.4 | 0.6 | 0.7 | 0.3 | 0.3 | 0.5 | 0.2 | 0.2 | 0.5 | 0.3 | 0.4 | 1.0 | 1.8 |
| | 8.0 | 6.6 | 0.7 | 0.5 | 0.6 | 0.8 | 0.4 | 0.4 | 0.3 | 0.7 | 0.7 | 0.7 | 0.8 | 1.0 | 2.0 | 2.5 |
| | 9.0 | 4.3 | 0.2 | 0.5 | 0.7 | 0.6 | 0.2 | 0.2 | 0.3 | 0.8 | 0.5 | 0.3 | 0.5 | 0.5 | 0.9 | 1.3 |
| | | 8.1 | 1.6 | 1.1 | 1.0 | 1.2 | 0.9 | 0.9 | 1.4 | 2.2 | 1.0 | 1.3 | 1.6 | 1.4 | 3.1 | 1.8 |
| | | 8.6 | 1.6 | 1.4 | 2.0 | 1.4 | 0.9 | 0.9 | 1.7 | 2.4 | 1.4 | 1.2 | 1.6 | 1.5 | 3.6 | 1.4 |
| | 10.0 | 9.2 | 1.9 | 1.5 | 2.1 | 2.1 | 1.6 | 1.0 | 1.4 | 1.6 | 1.8 | 1.7 | 1.3 | 1.6 | 2.1 | 1.8 |

(Continued)

Table 31 (Concluded)

| | Test Wave | | Wave Height, ft | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Plan | Period sec | Height ft | Gage 15 | Gage 16 | Gage 17 | Gage 18 | Gage 19 | Gage 20 | Gage 21 | Gage 22 | Gage 23 | Gage 24 | Gage 25 | Gage 26 | Gage 27 | Gage 28 | Gage 29 |
| 13D | 6.0 | 3.9 | 2.6 | 1.7 | 0.8 | 1.9 | 1.0 | 0.4 | 3.1 | 1.6 | 1.6 | 0.7 | 1.3 | 0.4 | 0.9 | 3.7 | 2.9 |
| | 7.0 | 5.5 | 2.5 | 1.6 | 0.5 | 0.3 | 0.5 | 1.1 | 1.3 | 1.9 | 1.9 | 1.1 | 0.7 | 2.7 | 1.8 | 2.7 | 5.4 |
| | 8.0 | 6.6 | 2.4 | 2.9 | 1.3 | 0.5 | 0.6 | 1.1 | 0.3 | 1.4 | 0.3 | 0.5 | 0.8 | 4.4 | 4.1 | 3.3 | 6.7 |
| | 9.0 | 4.3 | 1.7 | 0.8 | 0.5 | 0.6 | 0.7 | 1.4 | 1.0 | 0.7 | 0.2 | 0.5 | 0.9 | 1.2 | 4.0 | 2.7 | 2.6 |
| | | 8.1 | 4.1 | 2.4 | 2.6 | 3.1 | 1.9 | 1.9 | 2.5 | 1.4 | 0.9 | 1.6 | 2.0 | 3.4 | 6.8 | 6.5 | 9.0 |
| | | 8.6 | 4.1 | 3.3 | 2.8 | 3.2 | 2.3 | 3.0 | 2.3 | 1.6 | 1.0 | 1.6 | 2.1 | 2.8 | 6.5 | 6.2 | 7.2 |
| | 10.0 | 9.2 | 5.2 | 2.4 | 4.5 | 4.2 | 4.5 | 4.4 | 1.8 | 2.4 | 1.2 | 2.7 | 2.8 | 2.8 | 6.1 | 8.4 | 9.0 |
| 14 | 6.0 | 3.9 | 3.7 | 2.5 | 1.3 | 0.9 | 0.5 | 0.4 | 3.9 | 2.1 | 2.7 | 0.7 | 1.1 | 1.2 | 2.0 | 4.6 | 5.5 |
| | 7.0 | 5.5 | 3.3 | 1.7 | 1.1 | 0.6 | 0.9 | 0.7 | 1.6 | 2.2 | 1.8 | 1.3 | 1.6 | 0.7 | 1.3 | 3.9 | 7.6 |
| | 8.0 | 6.6 | 3.1 | 1.3 | 2.1 | 0.7 | 0.8 | 1.1 | 0.5 | 1.8 | 0.5 | 0.8 | 1.2 | 2.8 | 4.4 | 2.9 | 5.9 |
| | 9.0 | 4.3 | 1.0 | 2.3 | 0.6 | 1.1 | 1.3 | 1.7 | 1.3 | 0.8 | 0.2 | 0.8 | 1.1 | 0.8 | 3.7 | 3.8 | 5.9 |
| | | 8.1 | 4.6 | 2.1 | 2.6 | 3.0 | 2.4 | 2.1 | 2.3 | 1.2 | 1.0 | 1.4 | 2.1 | 3.2 | 6.3 | 6.8 | 10.0 |
| | | 8.6 | 3.7 | 2.0 | 1.9 | 3.3 | 2.3 | 2.2 | 2.0 | 1.6 | 1.2 | 1.8 | 2.0 | 2.2 | 6.5 | 6.6 | 11.1 |
| | 10.0 | 9.2 | 4.5 | 5.2 | 4.4 | 2.9 | 2.8 | 3.3 | 1.8 | 1.4 | 0.8 | 1.7 | 1.8 | 4.7 | 8.4 | 10.6 | 14.2 |
| 14A | 6.0 | 3.9 | 2.8 | 2.5 | 1.0 | 2.3 | 1.3 | 0.8 | 3.1 | 1.3 | 1.5 | 0.7 | 0.9 | 1.7 | 2.3 | 2.9 | 4.1 |
| | 7.0 | 5.5 | 2.5 | 2.3 | 0.8 | 0.7 | 0.9 | 0.6 | 1.2 | 1.4 | 1.0 | 1.0 | 1.2 | 1.5 | 1.3 | 4.9 | 6.1 |
| | 8.0 | 6.6 | 2.2 | 1.6 | 1.8 | 0.9 | 0.9 | 1.5 | 0.4 | 1.2 | 0.5 | 0.8 | 0.8 | 4.0 | 3.3 | 2.4 | 6.2 |
| | 9.0 | 4.3 | 1.0 | 2.8 | 0.3 | 1.5 | 0.9 | 1.0 | 0.8 | 0.7 | 0.2 | 0.6 | 1.3 | 1.1 | 3.8 | 2.8 | 5.9 |
| | | 8.1 | 3.0 | 1.3 | 1.1 | 3.1 | 2.1 | 2.4 | 2.6 | 1.2 | 1.0 | 1.2 | 1.6 | 2.5 | 5.9 | 4.6 | 11.3 |
| | | 8.6 | 3.5 | 1.6 | 1.9 | 3.4 | 2.5 | 2.7 | 2.4 | 1.3 | 0.8 | 1.2 | 1.5 | 3.0 | 5.9 | 5.3 | 11.7 |
| | 10.0 | 9.2 | 3.0 | 4.0 | 3.3 | 2.8 | 2.8 | 3.0 | 1.8 | 1.9 | 1.2 | 2.2 | 1.9 | 4.2 | 7.0 | 7.5 | 12.1 |
| 15 | 6.0 | 3.9 | 1.2 | 1.3 | 0.2 | 0.4 | 0.2 | <0.1 | 1.3 | 0.6 | 1.0 | 0.3 | 0.5 | 0.6 | 1.1 | 1.1 | 2.3 |
| | 7.0 | 5.5 | 2.8 | 1.1 | 0.8 | 0.9 | 0.7 | 0.6 | 0.8 | 1.7 | 2.1 | 0.9 | 1.2 | 2.6 | 1.7 | 2.4 | 3.9 |
| | 8.0 | 6.6 | 1.0 | 1.6 | 1.3 | 1.0 | 0.3 | 0.9 | 0.4 | 0.8 | 0.7 | 0.9 | 1.2 | 2.4 | 2.0 | 5.3 | 6.0 |
| | 9.0 | 4.3 | 0.8 | 1.5 | 0.6 | 1.2 | 0.8 | 1.0 | 1.1 | 0.4 | 0.5 | 0.8 | 1.1 | 0.9 | 2.7 | 1.5 | 4.1 |
| | | 8.1 | 2.7 | 2.8 | 1.3 | 1.7 | 0.9 | 1.6 | 1.1 | 1.8 | 0.8 | 1.6 | 0.9 | 3.9 | 4.6 | 3.6 | 8.2 |
| | | 8.6 | 2.9 | 3.6 | 1.7 | 1.7 | 0.7 | 1.4 | 1.1 | 1.8 | 1.2 | 1.7 | 1.2 | 4.1 | 5.4 | 4.8 | 9.3 |
| | 10.0 | 9.2 | 2.4 | 3.1 | 2.8 | 1.7 | 1.4 | 2.7 | 1.7 | 2.4 | 1.0 | 1.8 | 2.1 | 3.8 | 6.5 | 6.7 | 8.6 |

Table 32

Wave Heights for Severe-Weather Plan 15,

+4.8 ft swl, River Discharge 800 cfs

| Test Wave | | | Wave Height, ft | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Direction deg | Period sec | Height ft | Gage 1 | Gage 2 | Gage 3 | Gage 4 | Gage 5 | Gage 6 | Gage 7 | Gage 8 | Gage 9 | Gage 10 | Gage 11 | Gage 12 | Gage 13 | Gage 14 |
| 279 | 6.0 | 3.9 | <0.1 | 0.2 | 0.1 | 0.3 | 0.1 | 0.3 | 0.2 | 0.2 | 0.3 | 0.2 | 0.3 | 0.2 | 1.1 | 0.5 |
| | 7.0 | 5.5 | 0.3 | 0.3 | 0.4 | 0.5 | 0.2 | 0.4 | 0.4 | 0.3 | 0.2 | 0.2 | 0.3 | 0.2 | 1.0 | 1.9 |
| | 8.0 | 6.6 | 0.4 | 1.1 | 1.2 | 1.0 | 0.5 | 0.5 | 0.8 | 1.1 | 0.6 | 0.7 | 0.6 | 0.9 | 1.8 | 2.0 |
| | 9.0 | 4.3 | 0.7 | 0.7 | 1.7 | 0.4 | 0.5 | 0.4 | 0.6 | 0.6 | 0.7 | 0.7 | 1.1 | 0.8 | 1.4 | 1.6 |
| | | 8.1 | 2.5 | 2.8 | 3.2 | 2.4 | 1.2 | 1.0 | 2.3 | 2.6 | 2.0 | 1.0 | 1.3 | 1.3 | 2.3 | 2.8 |
| | | 8.6 | 2.8 | 2.6 | 3.3 | 1.8 | 1.4 | 1.5 | 2.6 | 2.3 | 1.6 | 1.3 | 1.6 | 2.1 | 2.3 | 1.3 |
| | 10.0 | 9.2 | 2.7 | 2.5 | 3.5 | 3.6 | 2.6 | 2.4 | 3.1 | 2.5 | 3.7 | 2.7 | 3.4 | 2.4 | 3.1 | 3.9 |
| 326 | 6.0 | 5.6 | 0.3 | 0.2 | 0.4 | 0.7 | 0.2 | 0.3 | 0.8 | 0.4 | 0.2 | 0.8 | 0.7 | 1.3 | 1.2 | 1.3 |
| | 7.0 | 8.0 | 1.5 | 1.3 | 1.3 | 1.4 | 1.0 | 0.6 | 1.9 | 0.8 | 0.6 | 0.5 | 0.8 | 0.8 | 1.0 | 1.5 |
| | 8.0 | 5.5 | 0.8 | 0.6 | 0.4 | 0.2 | 1.1 | 0.5 | 1.4 | 0.4 | 0.6 | 0.4 | 0.5 | 0.5 | 1.1 | 0.8 |
| | | 10.3 | 2.1 | 2.0 | 1.5 | 2.0 | 1.2 | 1.2 | 2.7 | 2.5 | 1.3 | 1.0 | 1.5 | 1.7 | 2.2 | 2.4 |
| | 8.5 | 10.7 | 2.6 | 2.7 | 1.6 | 1.5 | 1.6 | 1.8 | 2.9 | 3.0 | 1.8 | 1.7 | 1.6 | 1.4 | 1.9 | 3.7 |
| | 9.0 | 6.2 | 1.4 | 1.2 | 0.8 | 0.8 | 0.9 | 1.0 | 1.5 | 1.4 | 1.3 | 0.7 | 0.7 | 1.3 | 1.8 | 2.0 |
| | | 11.9 | 3.7 | 3.9 | 4.2 | 3.6 | 1.9 | 2.4 | 2.7 | 4.3 | 2.1 | 1.5 | 2.4 | 3.6 | 3.6 | 2.7 |
| | 10.0 | 13.7 | 4.3 | 7.5 | 5.2 | 7.4 | 3.6 | 4.9 | 3.7 | 6.6 | 3.7 | 2.7 | 3.0 | 3.6 | 5.0 | 5.8 |
| 17 | 6.0 | 4.7 | 0.2 | 0.2 | 0.2 | 0.1 | <0.1 | 0.8 | 0.6 | 0.2 | 0.3 | 0.3 | 0.8 | 0.4 | 1.1 | 1.2 |
| | 7.0 | 7.3 | 0.2 | 0.2 | 0.5 | 0.5 | 0.4 | 2.0 | 1.1 | 0.5 | 0.7 | 0.9 | 0.8 | 1.7 | 2.7 | 2.7 |
| | 8.0 | 5.1 | 1.0 | 0.5 | 0.7 | 0.6 | 1.2 | 1.0 | 1.1 | 1.1 | 0.8 | 1.3 | 1.1 | 2.2 | 2.3 | 2.7 |
| | | 8.9 | 1.0 | 0.8 | 1.2 | 0.8 | 1.6 | 1.9 | 2.0 | 1.3 | 1.3 | 1.9 | 1.7 | 3.5 | 3.6 | 3.6 |
| | | 9.8 | 1.2 | 0.8 | 1.1 | 0.7 | 1.5 | 1.9 | 1.7 | 1.5 | 1.5 | 2.2 | 2.3 | 3.7 | 3.4 | 4.5 |
| | 9.5 | 12.2 | 3.3 | 3.0 | 3.9 | 3.1 | 3.0 | 3.5 | 2.9 | 1.9 | 2.8 | 2.4 | 4.0 | 3.8 | 5.3 | 5.7 |

(Continued)

Table 32 (Concluded)

| Test Wave | | | Wave Height, ft | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Direction deg | Period sec | Height ft | Gage 15 | Gage 16 | Gage 17 | Gage 18 | Gage 19 | Gage 20 | Gage 21 | Gage 22 | Gage 23 | Gage 24 | Gage 25 | Gage 26 | Gage 27 | Gage 28 | Gage 29 |
| 279 | 6.0 | 3.9 | 2.0 | 1.3 | 0.4 | 1.1 | 0.6 | 0.8 | 0.9 | 0.7 | 1.3 | <0.1 | 0.6 | 0.7 | 2.5 | 1.2 | 2.8 |
| | 7.0 | 5.5 | 2.3 | 0.9 | 1.5 | 0.8 | 1.4 | 0.4 | 1.6 | 1.6 | 2.7 | 0.8 | 0.4 | 3.5 | 2.2 | 1.6 | 5.9 |
| | 8.0 | 6.6 | 1.3 | 1.4 | 2.9 | 0.8 | 0.8 | 1.2 | 0.7 | 1.8 | 1.1 | 1.3 | 1.0 | 5.3 | 4.3 | 3.9 | 4.1 |
| | 9.0 | 4.3 | 1.1 | 1.4 | 0.5 | 0.5 | 0.7 | 1.0 | 0.4 | 1.1 | 0.7 | 0.7 | 0.8 | 2.8 | 0.7 | 2.3 | 3.0 |
| | | 8.1 | 2.0 | 2.5 | 1.7 | 3.1 | 2.5 | 2.6 | 1.3 | 2.0 | 1.1 | 3.0 | 1.2 | 2.4 | 4.6 | 7.2 | 9.6 |
| | | 8.6 | 2.8 | 2.7 | 1.6 | 2.7 | 2.2 | 2.7 | 1.4 | 2.4 | 1.1 | 2.7 | 2.2 | 3.6 | 6.9 | 6.6 | 7.0 |
| | 10.0 | 9.2 | 2.1 | 4.0 | 1.9 | 2.7 | 1.5 | 3.8 | 2.1 | 4.6 | 2.0 | 5.3 | 1.8 | 6.4 | 5.6 | 6.1 | 9.6 |
| 326 | 6.0 | 5.6 | 1.8 | 1.2 | 0.6 | 1.2 | 0.3 | 0.8 | 0.7 | 0.5 | 1.3 | 0.6 | 1.0 | 1.1 | 1.8 | 1.5 | 2.1 |
| | 7.0 | 8.0 | 2.6 | 2.3 | 1.2 | 1.2 | 0.4 | 0.9 | 1.8 | 1.3 | 1.1 | 0.7 | 1.7 | 2.6 | 3.4 | 4.0 | 4.1 |
| | 8.0 | 5.5 | 1.7 | 1.4 | 1.0 | 0.6 | 0.5 | 0.7 | 1.2 | 1.0 | 1.7 | 0.6 | 1.3 | 1.6 | 1.9 | 2.6 | 2.4 |
| | | 10.3 | 3.8 | 4.5 | 2.0 | 2.5 | 1.6 | 2.6 | 1.1 | 2.8 | 4.2 | 2.3 | 4.8 | 4.8 | 3.4 | 5.0 | 4.0 |
| | 8.5 | 10.7 | 4.4 | 5.1 | 3.4 | 2.4 | 1.8 | 4.3 | 2.1 | 4.2 | 4.3 | 3.0 | 4.0 | 5.2 | 5.8 | 5.0 | 5.7 |
| | 9.0 | 6.2 | 2.3 | 2.0 | 1.5 | 1.6 | 1.1 | 2.5 | 1.2 | 1.7 | 1.6 | 1.2 | 2.2 | 3.1 | 2.1 | 1.7 | 5.4 |
| | | 11.9 | 3.4 | 5.7 | 3.8 | 4.1 | 4.3 | 6.0 | 4.5 | 5.9 | 3.7 | 4.8 | 7.1 | 6.4 | 5.6 | 6.6 | 4.9 |
| | 10.0 | 13.7 | 7.2 | 7.9 | 4.4 | 5.4 | 3.0 | 5.2 | 2.5 | 4.4 | 4.6 | 5.1 | 6.2 | 8.6 | 7.0 | 10.3 | 12.8 |
| 17 | 6.0 | 4.7 | 0.9 | 1.4 | 0.7 | 1.2 | <0.1 | 0.3 | 0.3 | 0.4 | 0.3 | 0.3 | 0.5 | 1.1 | 1.2 | 0.9 | 1.7 |
| | 7.0 | 7.3 | 2.2 | 3.0 | 0.5 | 1.7 | 0.7 | 0.4 | 0.4 | 0.5 | 0.8 | 0.5 | 1.9 | 2.4 | 2.8 | 1.3 | 2.2 |
| | 8.0 | 5.1 | 2.4 | 2.5 | 1.7 | 1.6 | 0.9 | 0.9 | 0.9 | 0.9 | 0.9 | 0.4 | 1.7 | 1.6 | 2.4 | 1.6 | 2.4 |
| | | 8.9 | 3.0 | 3.0 | 1.6 | 2.0 | 1.3 | 1.6 | 1.0 | 1.4 | 1.5 | 1.0 | 1.8 | 3.6 | 4.0 | 2.4 | 3.4 |
| | | 9.8 | 3.3 | 2.5 | 1.7 | 2.0 | 1.6 | 1.8 | 0.9 | 1.6 | 1.8 | 1.1 | 2.0 | 4.2 | 4.4 | 2.4 | 2.8 |
| | 9.5 | 12.2 | 7.3 | 8.0 | 4.1 | 4.2 | 2.4 | 5.0 | 2.2 | 2.7 | 1.4 | 2.5 | 2.6 | 7.4 | 7.1 | 5.8 | 7.4 |

Table 33

Wave Heights for Severe-Weather Plan 16,

+4.8 ft swl, River Discharge 800 cfs

| | Test Wave | | Wave Height, ft | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Plan | Period sec | Height ft | Gage 1 | Gage 2 | Gage 3 | Gage 4 | Gage 5 | Gage 6 | Gage 7 | Gage 8 | Gage 9 | Gage 10 | Gage 11 | Gage 12 | Gage 13 | Gage 14 |
| 279 | 6.0 | 3.9 | 0.2 | 0.2 | 0.3 | 0.3 | 0.1 | 0.2 | 0.2 | 0.1 | 0.2 | 0.2 | 0.2 | 0.3 | 0.3 | 0.5 |
| | 7.0 | 5.5 | 0.2 | 0.5 | 0.6 | 0.6 | 0.4 | 0.3 | 0.3 | 0.2 | 0.5 | 0.6 | 0.3 | 0.8 | 0.8 | 1.0 |
| | 8.0 | 6.6 | 1.3 | 1.7 | 1.3 | 1.0 | 0.5 | 0.4 | 0.8 | 1.0 | 0.8 | 0.6 | 0.7 | 0.6 | 1.1 | 1.6 |
| | 9.0 | 4.3 | 0.4 | 0.7 | 1.6 | 0.3 | 0.3 | 0.3 | 0.5 | 0.2 | 0.5 | 0.3 | 0.5 | 0.5 | 1.1 | 1.0 |
| | | 8.1 | 2.6 | 2.4 | 2.3 | 1.6 | 1.4 | 1.1 | 1.8 | 1.1 | 0.8 | 1.0 | 1.6 | 1.5 | 2.1 | 3.2 |
| | | 8.6 | 3.3 | 2.4 | 2.8 | 1.6 | 1.4 | 1.0 | 2.0 | 1.3 | 1.1 | 1.1 | 1.7 | 2.0 | 2.8 | 2.5 |
| | 10.0 | 9.2 | 2.4 | 2.8 | 2.0 | 3.9 | 2.5 | 2.8 | 2.3 | 1.8 | 3.1 | 1.8 | 3.4 | 3.2 | 3.0 | 4.4 |
| 326 | 6.0 | 5.6 | 0.4 | 0.3 | 0.2 | 0.6 | 0.6 | 1.0 | 1.8 | 0.4 | 0.5 | 2.9 | 2.0 | 3.5 | 4.1 | 4.1 |
| | 7.0 | 8.0 | 1.8 | 1.7 | 1.1 | 1.5 | 1.0 | 1.8 | 3.1 | 0.6 | 2.0 | 2.5 | 1.8 | 3.7 | 4.1 | 6.0 |
| | 8.0 | 5.5 | 0.8 | 0.7 | 0.4 | 0.4 | 0.9 | 1.3 | 1.4 | 0.8 | 0.7 | 0.8 | 1.9 | 1.7 | 2.1 | 2.5 |
| | | 10.3 | 2.3 | 2.6 | 2.3 | 1.8 | 1.6 | 2.1 | 3.5 | 2.3 | 2.7 | 1.8 | 2.0 | 2.6 | 5.1 | 4.9 |
| | 8.5 | 10.7 | 2.2 | 2.2 | 1.6 | 2.5 | 2.1 | 2.9 | 3.6 | 2.6 | 3.1 | 2.1 | 2.8 | 3.1 | 3.6 | 5.3 |
| | 9.0 | 6.2 | 1.9 | 1.9 | 1.4 | 1.0 | 1.7 | 1.3 | 1.0 | 1.9 | 1.1 | 1.2 | 1.4 | 2.1 | 3.2 | 4.4 |
| | | 11.9 | 3.0 | 2.8 | 4.2 | 3.9 | 3.5 | 2.o | 3.0 | 4.3 | 3.5 | 3.9 | 4.4 | 4.5 | 6.2 | 6.5 |
| | 10.0 | 13.7 | 5.4 | 6.1 | 6.1 | 8.8 | 5.5 | 4.9 | 5.5 | 6.0 | 5.8 | 4.8 | 5.3 | 5.5 | 7.3 | 8.7 |
| 17 | 6.0 | 4.7 | 0.2 | 0.2 | 0.2 | 0.2 | 0.4 | 0.8 | 0.2 | 0.4 | 0.2 | 0.6 | 0.5 | 0.4 | 0.8 | 0.5 |
| | 7.0 | 7.3 | 0.5 | 0.6 | 0.5 | 0.4 | 0.8 | 1.4 | 1.5 | 0.6 | 0.7 | 0.8 | 0.7 | 1.8 | 2.0 | 1.5 |
| | 8.0 | 5.1 | 1.3 | 1.1 | 0.6 | 0.8 | 1.0 | 0.9 | 0.7 | 0.7 | 0.8 | 1.0 | 1.2 | 1.3 | 1.5 | 2.0 |
| | | 8.9 | 1.4 | 1.9 | 2.1 | 1.3 | 1.6 | 1.7 | 1.6 | 1.3 | 0.8 | 1.6 | 1.7 | 3.2 | 3.0 | 3.4 |
| | | 9.8 | 1.3 | 1.5 | 1.7 | 1.3 | 1.5 | 1.2 | 1.8 | 1.8 | 1.0 | 1.7 | 1.3 | 3.6 | 2.9 | 3.4 |
| | 9.5 | 12.2 | 3.7 | 4.0 | 4.1 | 4.2 | 3.2 | 2.9 | 2.6 | 2.8 | 3.5 | 2.9 | 4.6 | 5.1 | 6.8 | 5.5 |

(Continued)

Table 33 (Concluded)

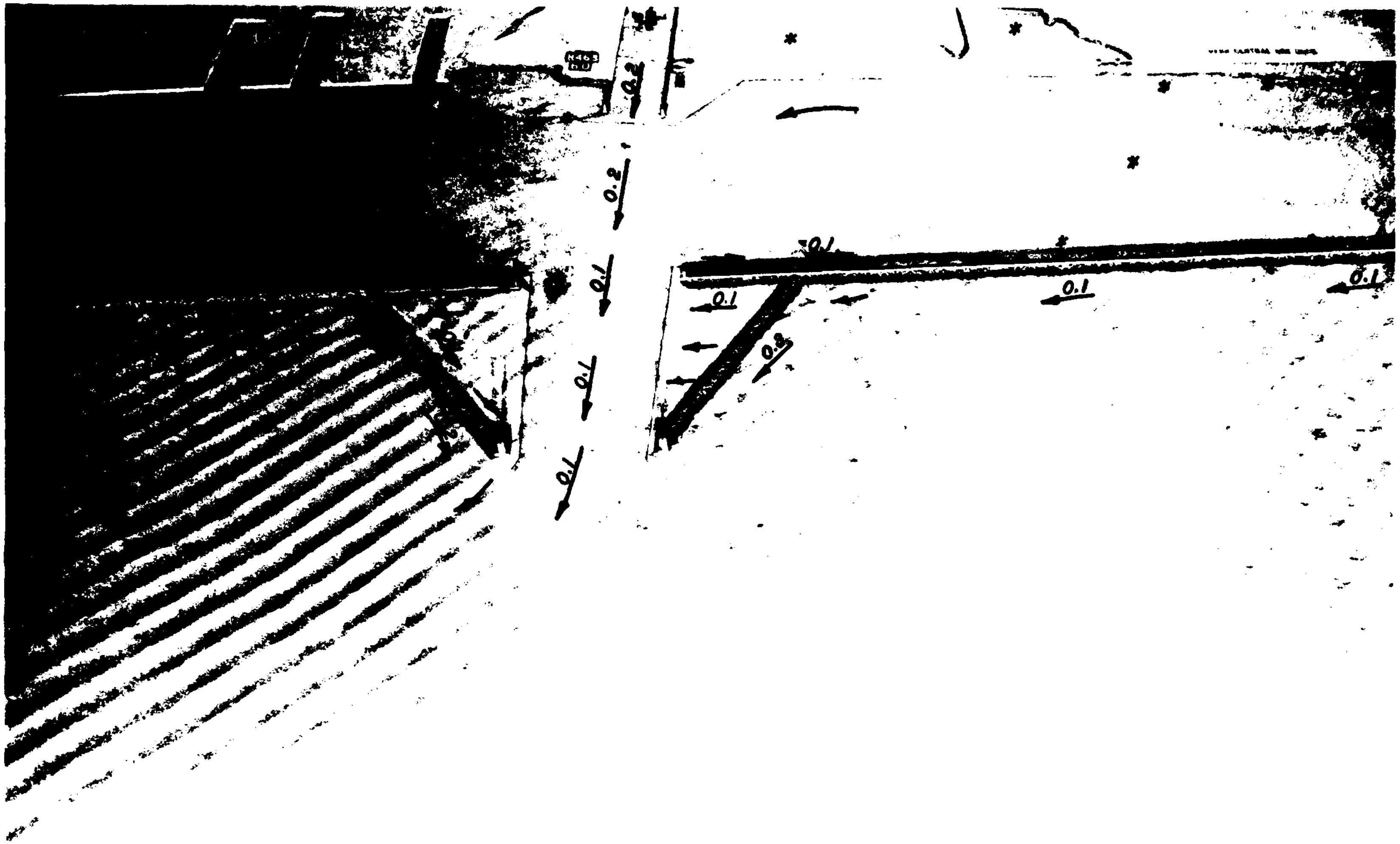
| Test Wave | | | Wave Height, ft | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Direction deg | Period sec | Height ft | Gage 15 | Gage 16 | Gage 17 | Gage 18 | Gage 19 | Gage 20 | Gage 21 | Gage 22 | Gage 23 | Gage 24 | Gage 25 | Gage 30 | Gage 31 |
| 279 | 6.0 | 3.9 | 0.5 | 0.2 | 0.2 | 0.8 | 0.5 | 0.4 | 0.5 | 0.2 | 0.2 | <0.1 | 0.3 | 1.4 | 1.9 |
| | 7.0 | 5.5 | 0.6 | 1.7 | 0.9 | 0.3 | 0.4 | 0.7 | 0.5 | 0.5 | 0.7 | 0.4 | 0.2 | 1.6 | 4.1 |
| | 8.0 | 6.6 | 1.1 | 2.0 | 1.4 | 0.6 | 0.9 | 1.2 | 0.8 | 1.0 | 0.5 | 0.6 | 0.8 | 3.4 | 4.0 |
| | 9.0 | 4.3 | 0.8 | 1.4 | 0.4 | 1.1 | 0.8 | 0.6 | 0.4 | 0.7 | 0.3 | 0.3 | 0.3 | 1.0 | 2.9 |
| | | 8.1 | 1.7 | 1.5 | 2.1 | 2.0 | 1.5 | 2.2 | 1.4 | 1.5 | 1.1 | 1.3 | 1.5 | 2.9 | 5.5 |
| | | 8.6 | 2.4 | 2.0 | 2.1 | 2.6 | 2.3 | 2.3 | 1.5 | 1.8 | 1.4 | 1.9 | 2.0 | 2.9 | 6.4 |
| | 10.0 | 9.2 | 2.3 | 2.3 | 2.8 | 2.8 | 1.5 | 3.8 | 2.3 | 2.1 | 2.4 | 2.4 | 2.7 | 3.0 | 7.3 |
| 326 | 6.0 | 5.6 | 6.0 | 5.5 | 2.7 | 1.6 | 0.2 | 0.6 | 0.8 | 0.6 | 1.2 | 0.4 | 0.9 | 5.0 | 5.3 |
| | 7.0 | 8.0 | 8.0 | 9.6 | 4.9 | 1.3 | 2.1 | 0.7 | 1.5 | 1.0 | 1.3 | 0.8 | 2.0 | 11.2 | 8.1 |
| | 8.0 | 5.5 | 3.8 | 5.7 | 3.6 | 1.3 | 0.8 | 0.8 | 0.8 | 1.0 | 2.0 | 1.1 | 1.8 | 4.9 | 4.3 |
| | | 10.3 | 6.5 | 10.8 | 5.6 | 3.0 | 3.1 | 2.7 | 2.4 | 3.0 | 3.9 | 2.7 | 3.3 | 15.2 | 12.5 |
| | 8.5 | 10.7 | 8.5 | 9.6 | 3.2 | 3.3 | 2.2 | 3.9 | 3.0 | 3.2 | 3.0 | 2.8 | 3.5 | 15.7 | 12.2 |
| | 9.0 | 6.2 | 5.3 | 4.6 | 3.8 | 2.2 | 1.9 | 2.5 | 2.1 | 1.6 | 1.4 | 1.2 | 3.1 | 6.9 | 5.4 |
| | | 11.9 | 8.0 | 10.2 | 5.3 | 7.0 | 5.1 | 5.7 | 3.2 | 4.4 | 3.6 | 5.1 | 4.8 | 18.6 | 15.6 |
| | 10.0 | 13.7 | 10.1 | 16.9 | 6.8 | 5.7 | 3.3 | 6.7 | 4.0 | 5.3 | 3.8 | 5.2 | 7.1 | 21.4 | 23.1 |
| 17 | 6.0 | 4.7 | 1.7 | 1.5 | 0.9 | 1.0 | 0.1 | 0.2 | 0.4 | 0.2 | 0.3 | 0.1 | 0.8 | 3.2 | 4.8 |
| | 7.0 | 7.3 | 1.8 | 1.7 | 0.6 | 1.2 | 0.4 | 0.7 | 0.6 | 0.7 | 0.6 | 0.4 | 1.0 | 2.5 | 5.4 |
| | 8.0 | 5.1 | 2.4 | 2.6 | 2.6 | 1.3 | 1.2 | 1.3 | 0.6 | 0.6 | 0.7 | 0.8 | 1.2 | 3.2 | 5.1 |
| | | 8.9 | 2.9 | 4.9 | 1.5 | 1.4 | 1.3 | 1.0 | 0.8 | 1.0 | 1.2 | 0.8 | 1.7 | 5.9 | 5.9 |
| | | 9.8 | 2.8 | 5.4 | 2.1 | 2.6 | 1.0 | 1.3 | 0.8 | 1.1 | 1.3 | 0.7 | 1.7 | 4.9 | 6.4 |
| | 9.5 | 12.2 | 6.4 | 7.6 | 4.8 | 4.0 | 2.7 | 3.3 | 1.9 | 2.2 | 1.0 | 2.1 | 2.4 | 11.8 | 15.5 |

Table 34

Comparison of Wave Heights for Existing Conditions (EC) and Severe-Weather Plan 16, +4.8 ft swl, River Discharge 800 cfs

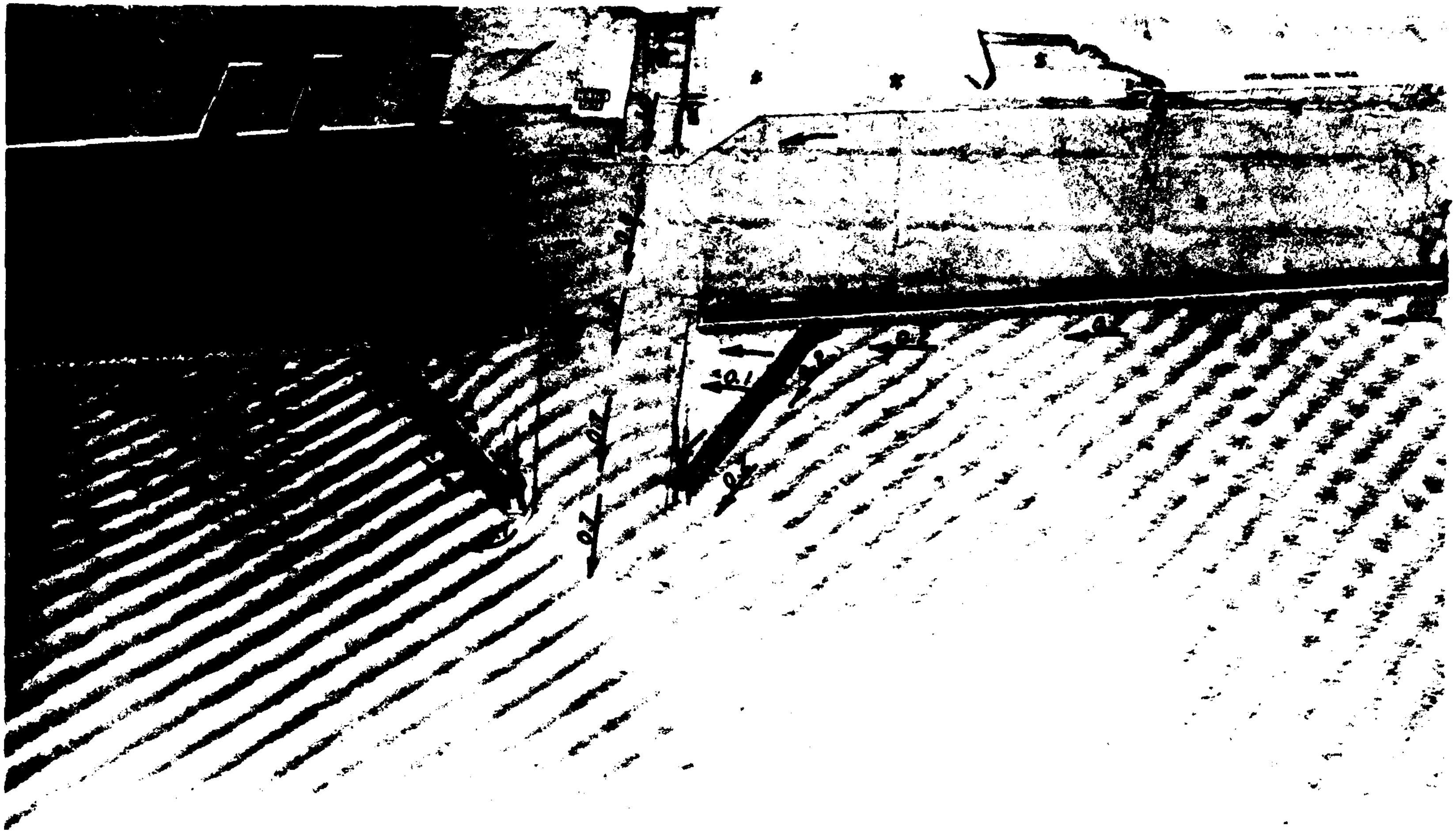
| Plan No. | Gage 1 | Gage 2 | Gage 3 | Gage 4 | Gage 5 | Gage 6 | Gage 7 | Gage 8 | Gage 9 | Gage 10 | Gage 11 | Gage 12 | Gage 13 | Gage 14 | Gage 15 | Gage 16 | Gage 17 | Gage 18 | Gage 19 | Gage 20 | Gage 21 | Gage 22 | Gage 23 | Gage 24 | Gage 25 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 9-sec, 8.6-ft Waves* from 279 deg | | | | | | | | | | | | | | | | | | | | | | | | | |
| EC | 4.4 | 2.1 | 3.6 | 2.5 | 1.8 | 1.7 | 2.4 | 1.8 | 2.2 | 1.7 | 2.1 | 2.6 | 3.7 | 4.7 | 6.4 | 13.1 | 2.0 | 4.7 | 2.9 | 5.7 | 3.1 | 4.4 | 2.1 | 1.8 | 3.0 |
| 16 | 3.3 | 2.4 | 2.8 | 1.6 | 1.4 | 1.0 | 2.0 | 1.3 | 1.1 | 1.1 | 1.7 | 2.0 | 2.8 | 2.5 | 2.4 | 2.0 | 2.1 | 2.6 | 2.3 | 2.3 | 1.5 | 1.8 | 1.4 | 1.9 | 2.0 |
| 10-sec, 9.2-ft Waves** from 279 deg | | | | | | | | | | | | | | | | | | | | | | | | | |
| EC | 3.3 | 3.0 | 3.5 | 3.0 | 3.3 | 3.9 | 3.6 | 2.7 | 3.0 | 1.3 | 2.6 | 2.9 | 3.3 | 8.1 | 7.7 | 13.4 | 2.8 | 5.7 | 4.1 | 6.1 | 4.3 | 6.1 | 2.8 | 4.7 | 3.1 |
| 16 | 2.4 | 2.8 | 2.0 | 3.9 | 2.5 | 2.8 | 2.3 | 1.8 | 3.1 | 1.8 | 3.4 | 3.2 | 3.0 | 4.4 | 2.3 | 2.3 | 2.8 | 2.8 | 1.5 | 3.8 | 2.3 | 2.1 | 2.4 | 2.4 | 2.7 |
| 9-sec, 11.9-ft Waves* from 326 deg | | | | | | | | | | | | | | | | | | | | | | | | | |
| EC | 5.1 | 5.6 | 7.3 | 5.3 | 6.0 | 5.1 | 5.2 | 7.1 | 5.6 | 5.8 | 7.4 | 8.2 | 10.1 | 12.3 | 18.7 | 17.4 | 8.8 | 6.6 | 5.3 | 5.7 | 4.5 | 5.3 | 5.4 | 5.5 | 6.3 |
| 16 | 3.0 | 2.8 | 4.2 | 3.9 | 3.5 | 2.6 | 3.0 | 4.3 | 3.5 | 3.9 | 4.4 | 4.5 | 6.2 | 6.5 | 8.0 | 10.2 | 5.3 | 7.0 | 5.1 | 5.7 | 3.2 | 4.4 | 3.6 | 5.1 | 4.8 |
| 10-sec, 13.7-ft Waves** from 326 deg | | | | | | | | | | | | | | | | | | | | | | | | | |
| EC | 5.8 | 6.8 | 9.1 | 9.4 | 5.8 | 6.1 | 7.3 | 7.6 | 7.0 | 7.3 | 8.9 | 8.1 | 11.7 | 14.4 | 18.3 | 26.2 | 8.5 | 9.1 | 5.4 | 7.0 | 5.5 | 6.0 | 5.8 | 6.0 | 5.5 |
| 16 | 5.4 | 6.1 | 6.1 | 8.8 | 5.5 | 4.9 | 5.5 | 6.0 | 5.8 | 4.8 | 5.3 | 5.5 | 7.3 | 8.7 | 10.1 | 16.9 | 6.8 | 5.7 | 3.3 | 6.7 | 4.0 | 5.3 | 3.8 | 5.2 | 7.1 |
| 8-sec, 9.8-ft Waves* from 17 deg | | | | | | | | | | | | | | | | | | | | | | | | | |
| EC | 1.2 | 1.9 | 2.2 | 1.5 | 1.9 | 2.4 | 3.0 | 1.8 | 1.8 | 1.3 | 3.8 | 3.4 | 4.8 | 5.8 | 7.4 | 10.6 | 3.1 | 2.5 | 1.7 | 1.6 | 1.8 | 1.4 | 1.0 | 1.2 | 2.5 |
| 16 | 1.3 | 1.3 | 1.7 | 1.3 | 1.5 | 1.2 | 1.8 | 1.8 | 1.0 | 1.7 | 1.3 | 3.6 | 2.9 | 3.4 | 2.8 | 5.4 | 2.1 | 2.6 | 1.0 | 1.3 | 0.8 | 1.1 | 1.3 | 0.7 | 1.7 |
| 9.5-sec, 12.2-ft Waves** from 17 deg | | | | | | | | | | | | | | | | | | | | | | | | | |
| EC | 5.6 | 6.7 | 6.7 | 7.0 | 4.4 | 4.2 | 6.0 | 7.1 | 4.2 | 3.5 | 4.8 | 6.5 | 6.8 | 9.8 | 11.9 | 24.0 | 4.4 | 3.3 | 2.4 | 3.8 | 2.4 | 3.1 | 1.7 | 3.9 | 3.4 |
| 16 | 3.7 | 4.0 | 4.1 | 4.2 | 3.2 | 2.9 | 2.6 | 2.8 | 3.5 | 2.9 | 4.6 | 5.1 | 6.8 | 5.5 | 6.4 | 7.6 | 4.8 | 4.0 | 2.7 | 3.3 | 1.9 | 2.2 | 1.0 | 2.1 | 2.4 |

* 20-year recurrence interval.
** 100-year recurrence interval.



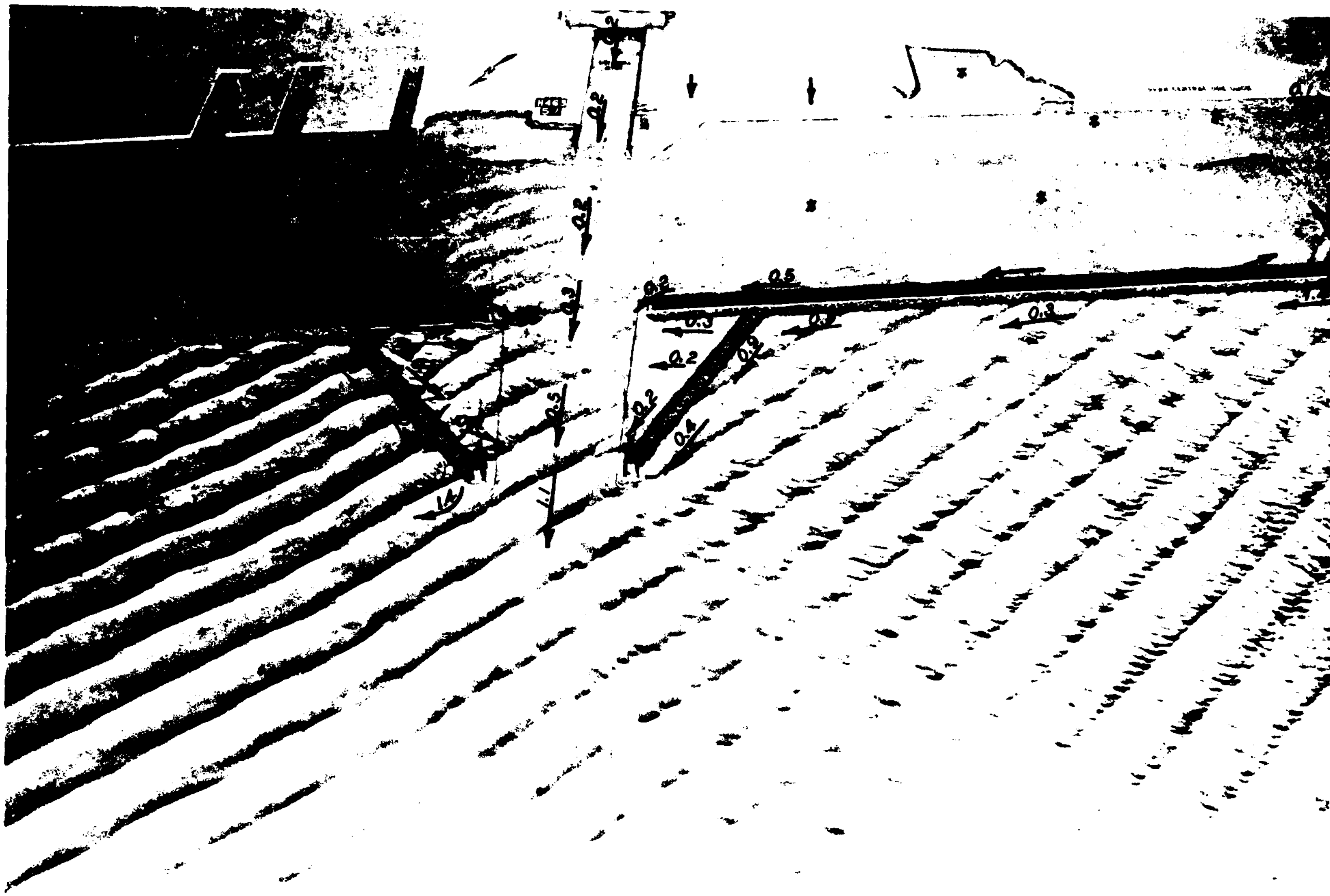

* INDICATES NO CURRENT MOVEMENT

Photo 1. Typical wave patterns, current patterns, and current magnitudes (prototype feet per second) for existing conditions; 6-sec, 3.9-ft waves from 279 deg; 0.0-ft swl; river discharge 800 cfs



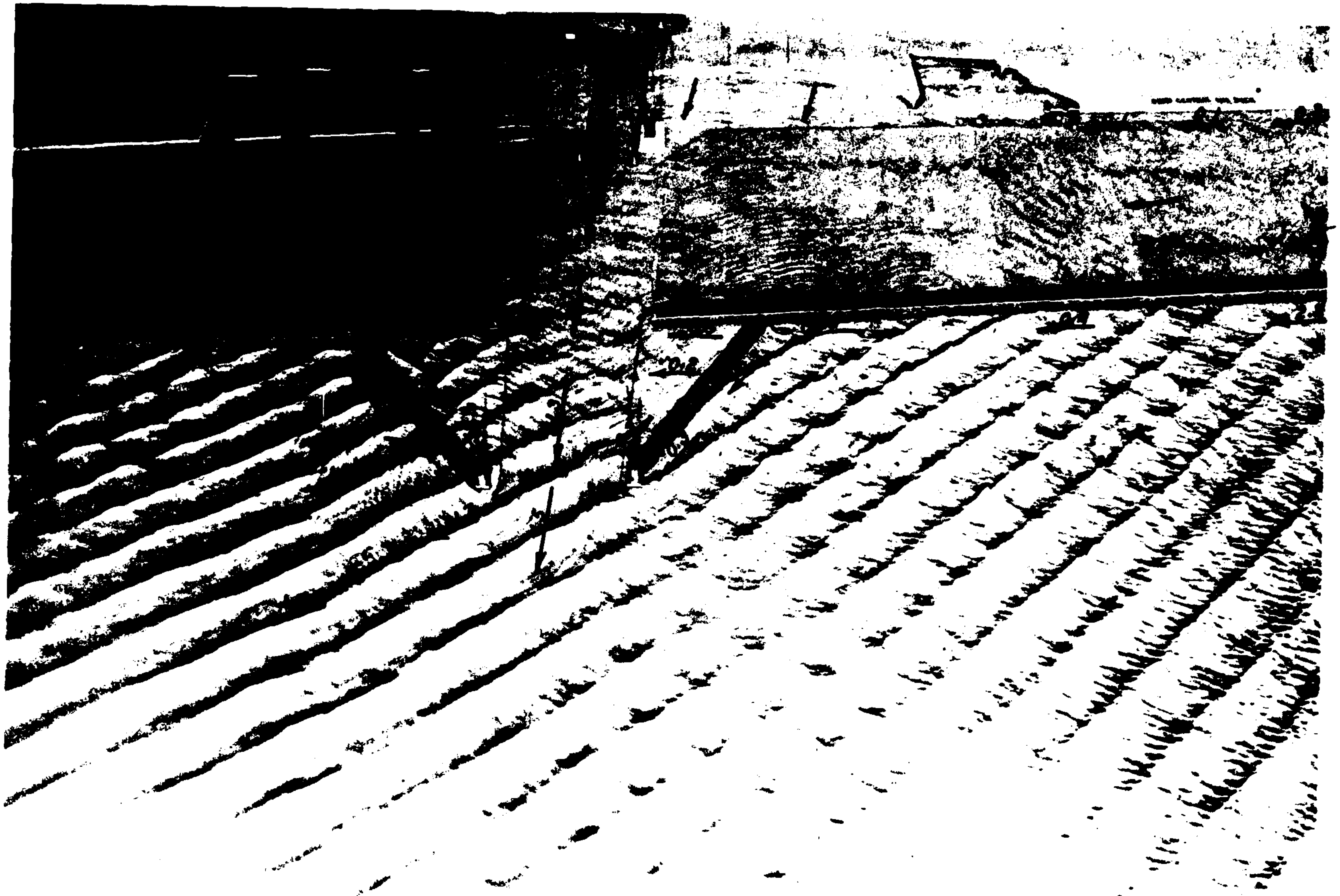
* INDICATES NO CURRENT MOVEMENT

Photo 2. Typical wave patterns, current patterns, and current magnitudes (prototype feet per second) for existing conditions; 6-sec, 3.9-ft waves from 279 deg; 0.0-ft swl; river discharge 8,000 cfs



* INDICATES NO CURRENT MOVEMENT

Photo 3. Typical wave patterns, current patterns, and current magnitudes (prototype feet per second) for existing conditions; 9-sec, 8.6-ft waves from 279 deg; 0.0-ft swl; river discharge 800 cfs



* INDICATES NO CURRENT MOVEMENT

Photo 4. Typical wave patterns, current patterns, and current magnitudes (prototype feet per second) for existing conditions; 9-sec, 8.6-ft waves from 279 deg; 0.0-ft swl; river discharge 8,000 cfs

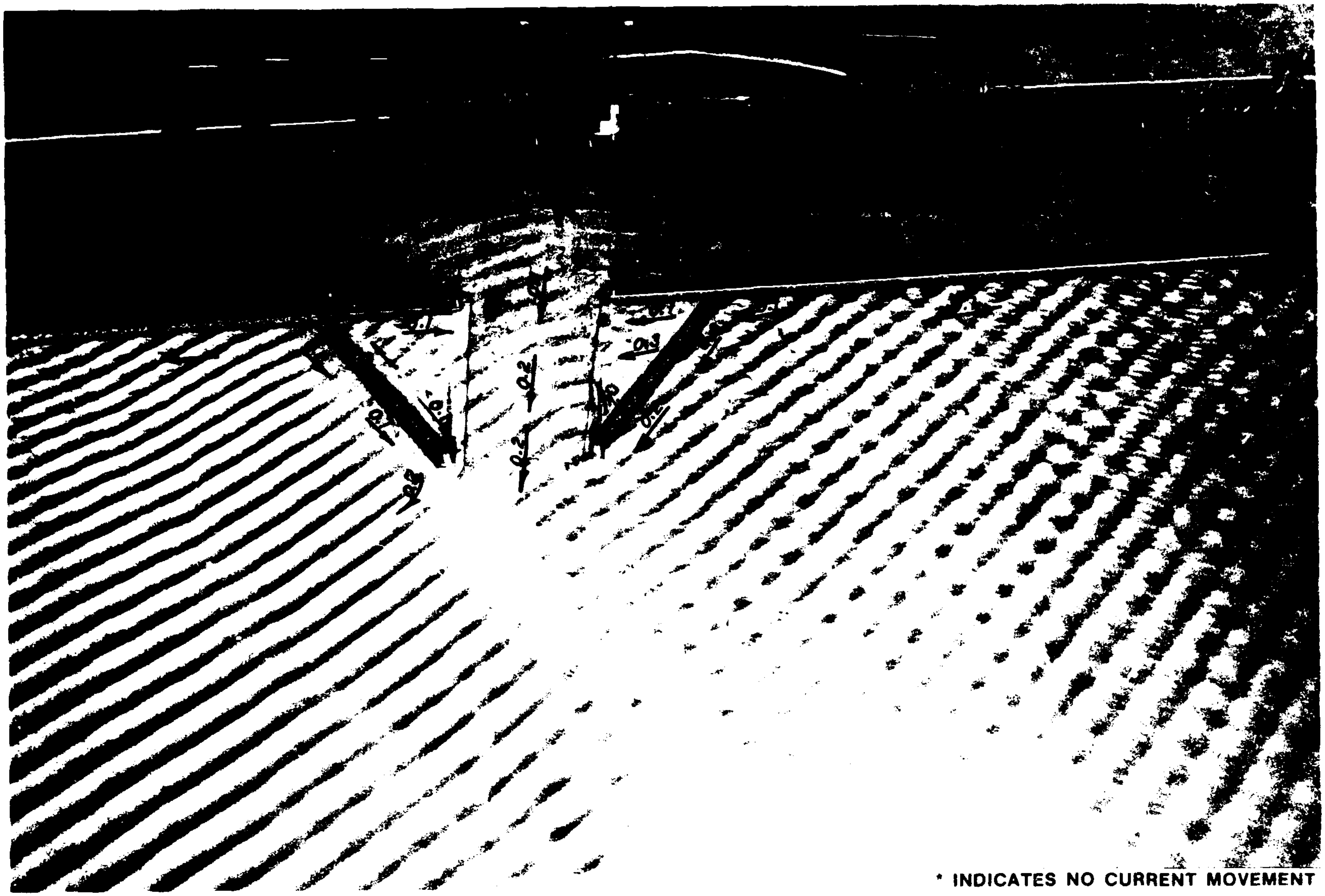
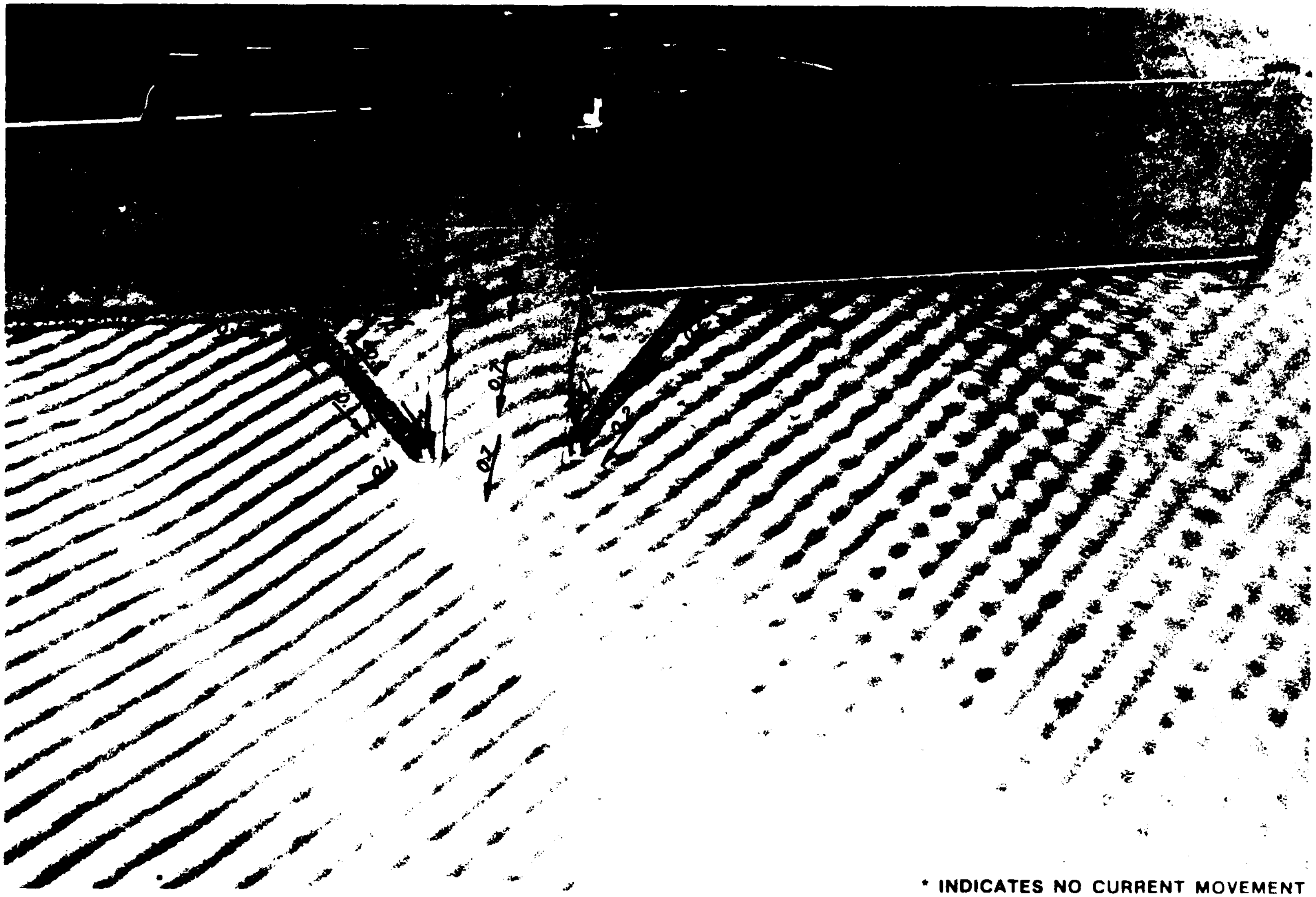



Photo 5. Typical wave patterns, current patterns, and current magnitudes (prototype feet per second) for existing conditions; 6-sec, 3.9-ft waves from 279 deg; +2.6 ft swl; river discharge 800 cfs



* INDICATES NO CURRENT MOVEMENT

Photo 6. Typical wave patterns, current patterns, and current magnitudes (prototype feet per second) for existing conditions; 6-sec, 3.9-ft waves from 279 deg; +2.6 ft swl; river discharge 8,000 cfs

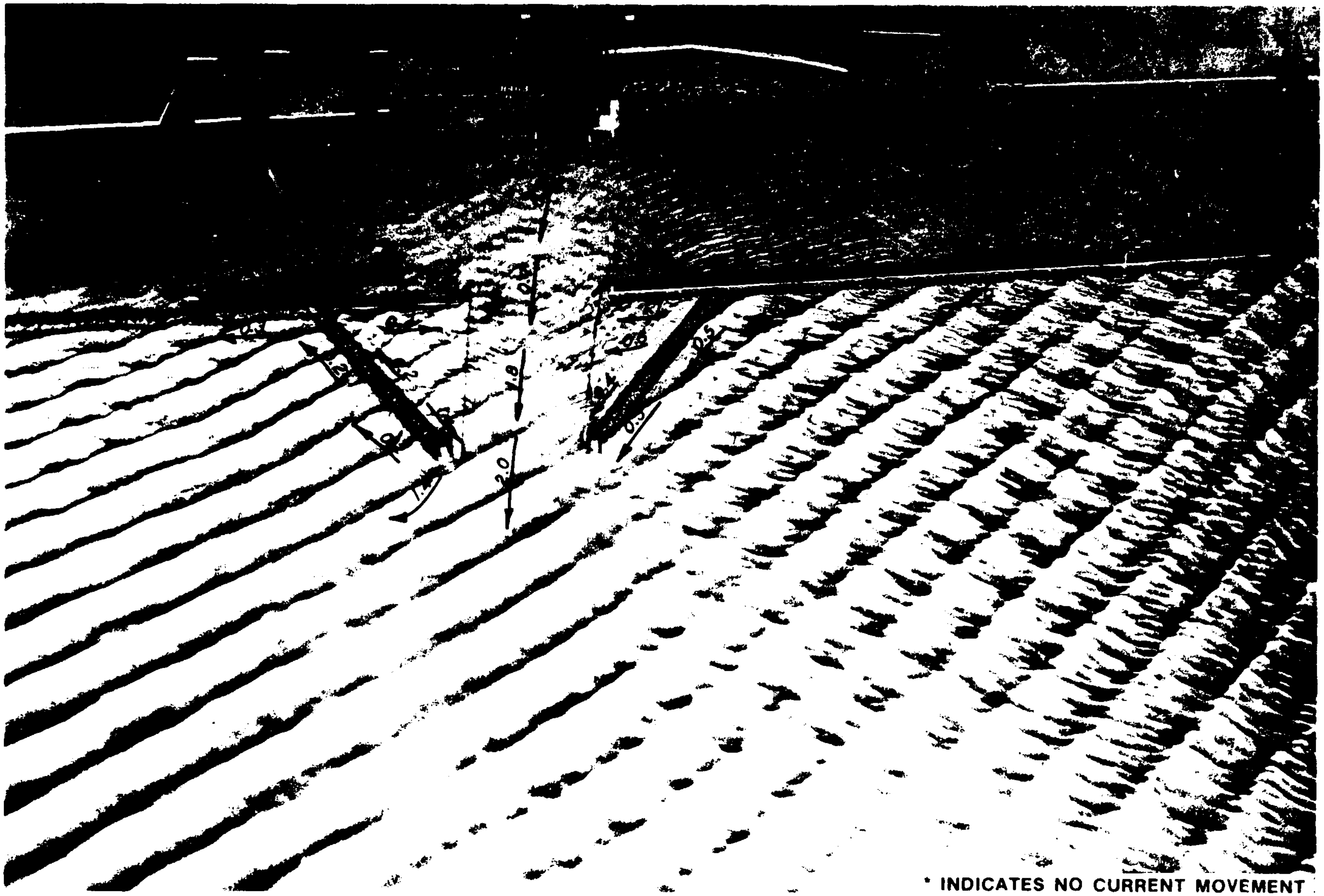



Photo 7. Typical wave patterns, current patterns, and current magnitudes (prototype feet per second) for existing conditions; 9-sec, 8.6-ft waves from 279 deg; +2.6 ft swl; river discharge 800 cfs

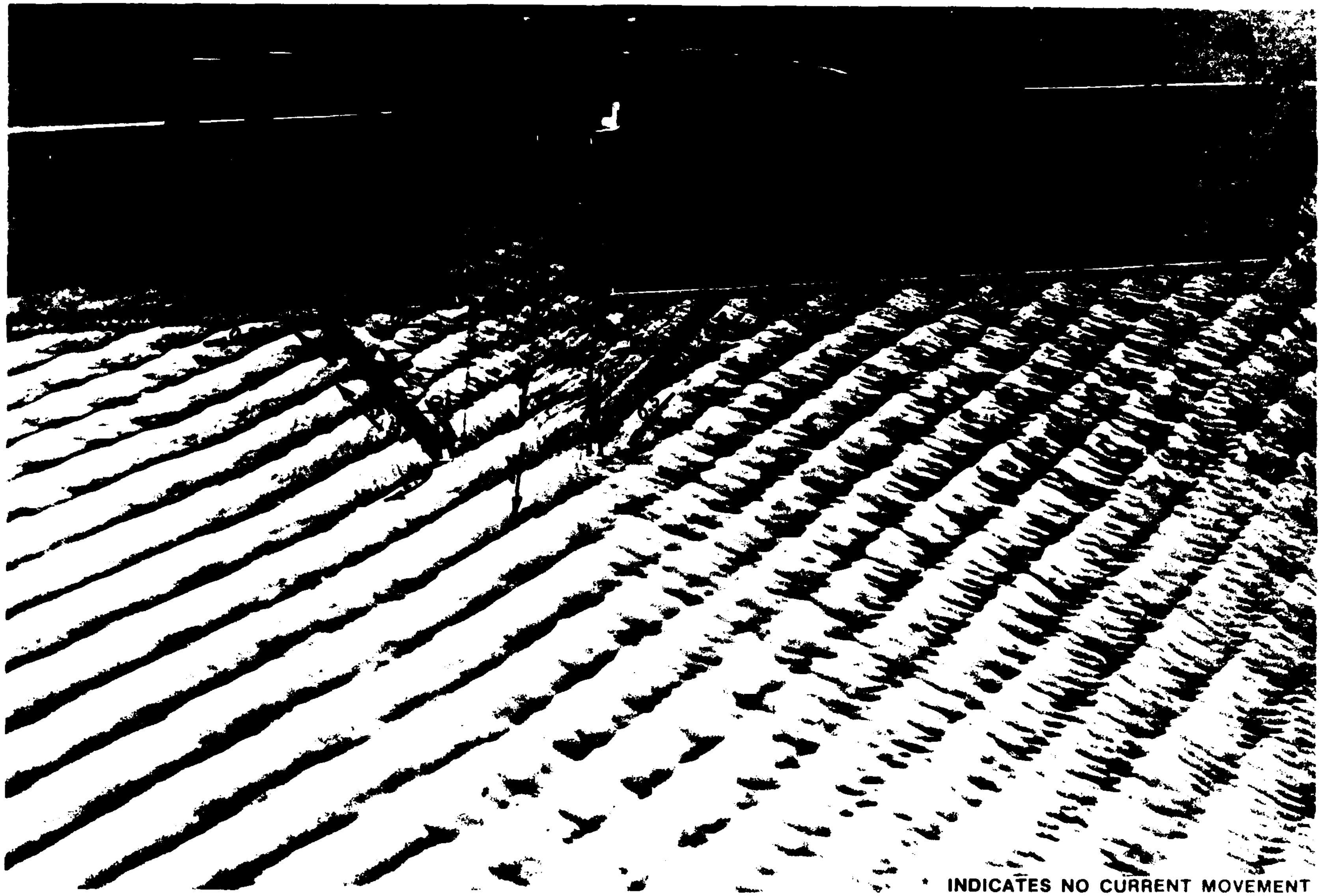
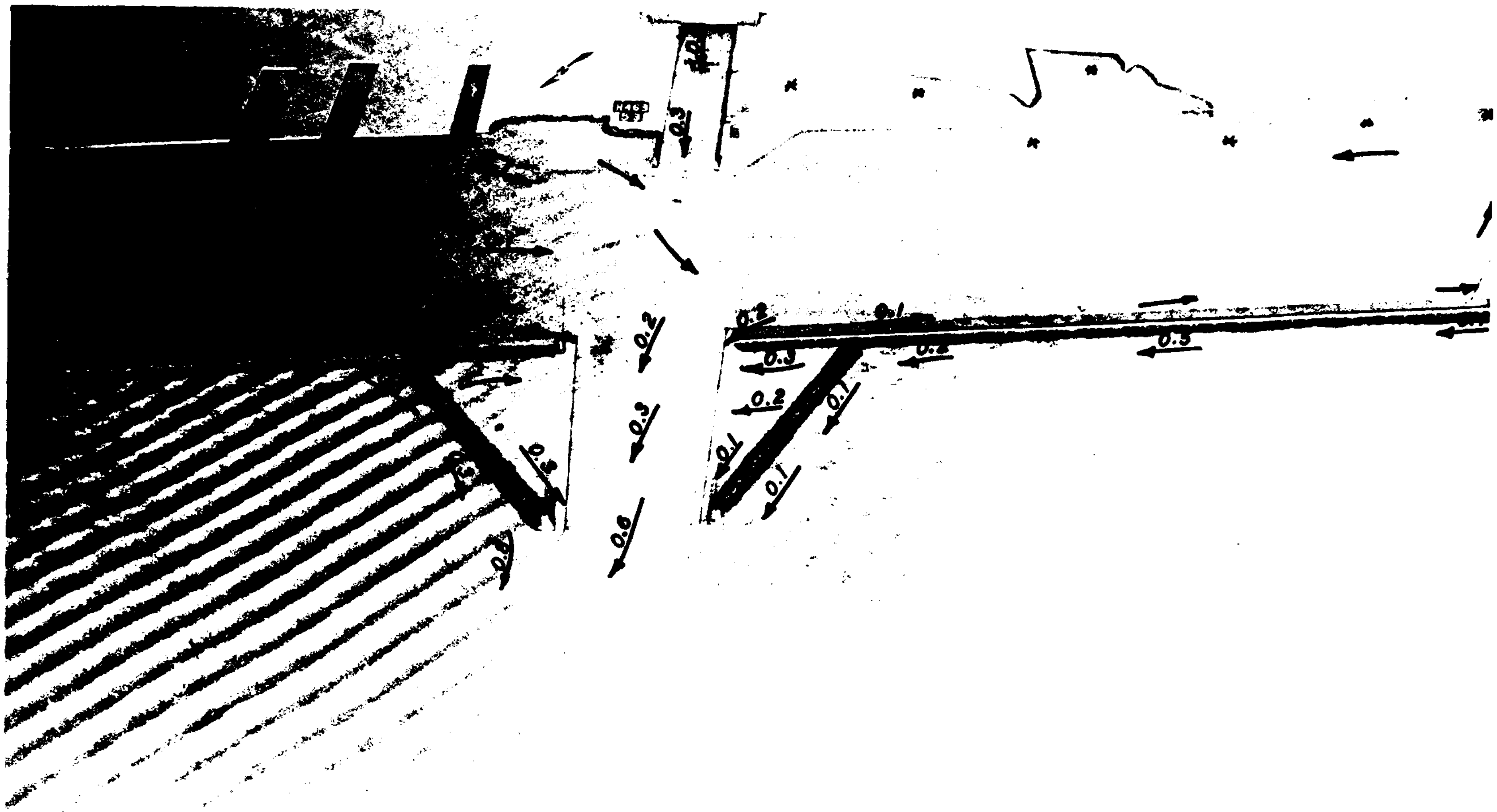
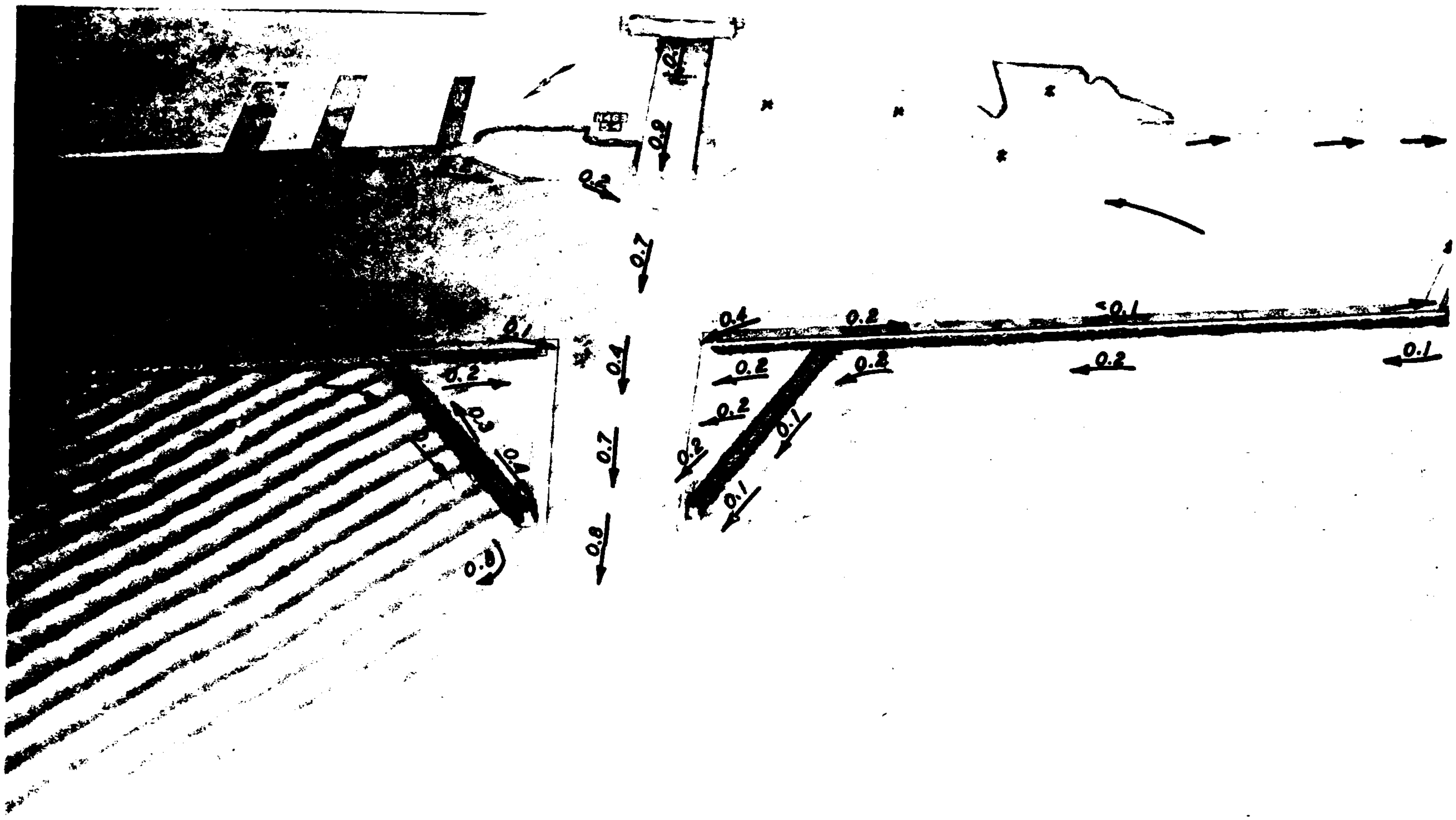



Photo 8. Typical wave patterns, current patterns, and current magnitudes (prototype feet per second) for existing conditions; 9-sec, 8.6-ft waves from 279 deg; +2.6 ft swl; river discharge 8,000 cfs



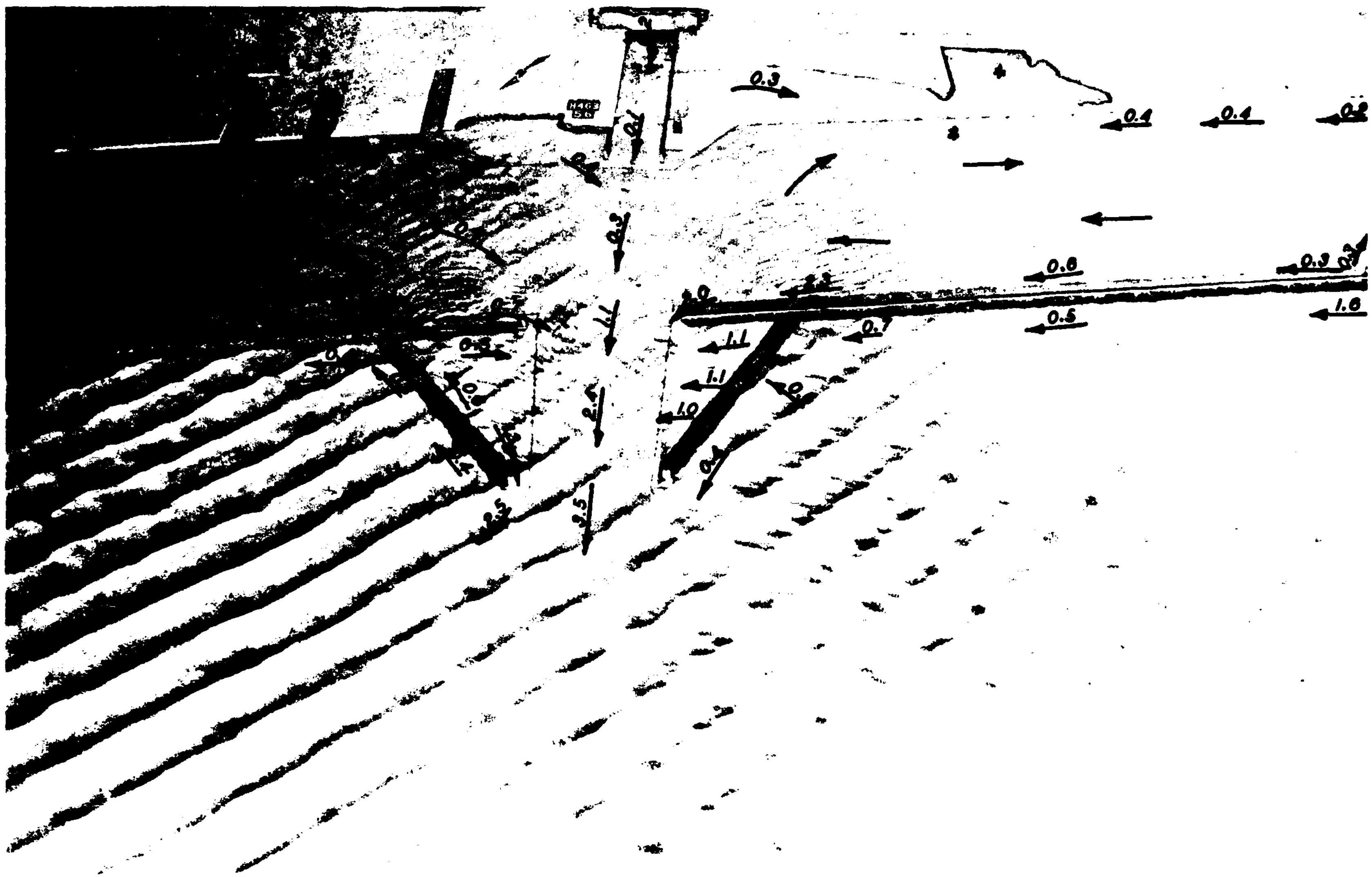
* INDICATES NO CURRENT MOVEMENT

Photo 9. Typical wave patterns, current patterns, and current magnitudes (prototype feet per second) for existing conditions; 6-sec, 3.9-ft waves from 279 deg; +4.8 ft swl; river discharge 800 cfs



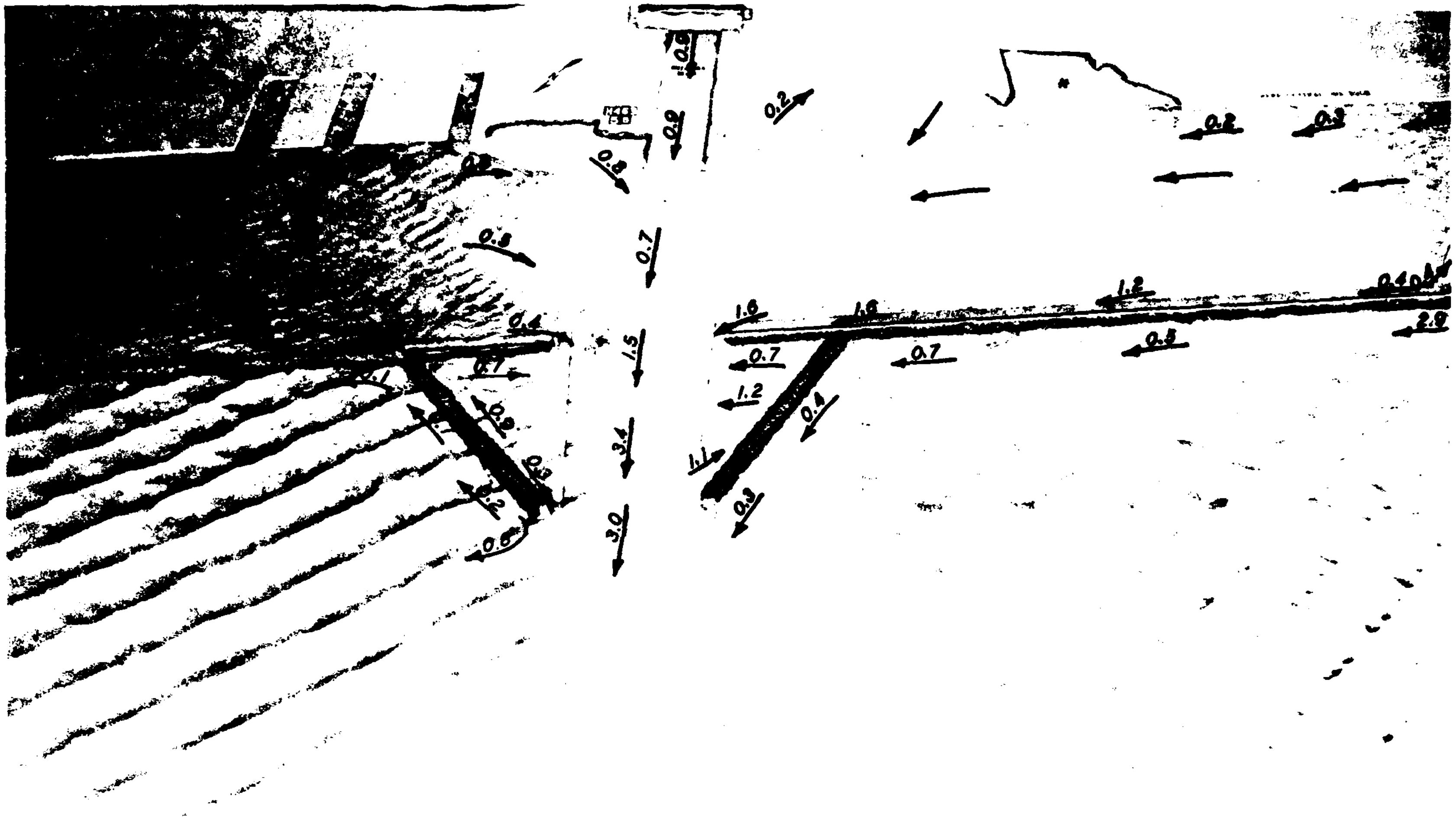

* INDICATES NO CURRENT MOVEMENT

Photo 10. Typical wave patterns, current patterns and current magnitudes (prototype feet per second) for existing conditions; 6-sec, 3.9-ft waves from 279 deg; +4.8 ft swl; river discharge 8,000 cfs



• INDICATES NO CURRENT MOVEMENT

Photo 11. Typical wave patterns, current patterns, and current magnitudes (prototype feet per second) for existing conditions; 9-sec, 8.6-ft waves from 279 deg; +4.8 ft swl; river discharge 800 cfs




* INDICATES NO CURRENT MOVEMENT

Photo 12. Typical wave patterns, current patterns, and current magnitudes (prototype feet per second) for existing conditions; 9-sec, 8.6-ft waves from 279 deg; +4.8 ft swl; river discharge 8,000 cfs

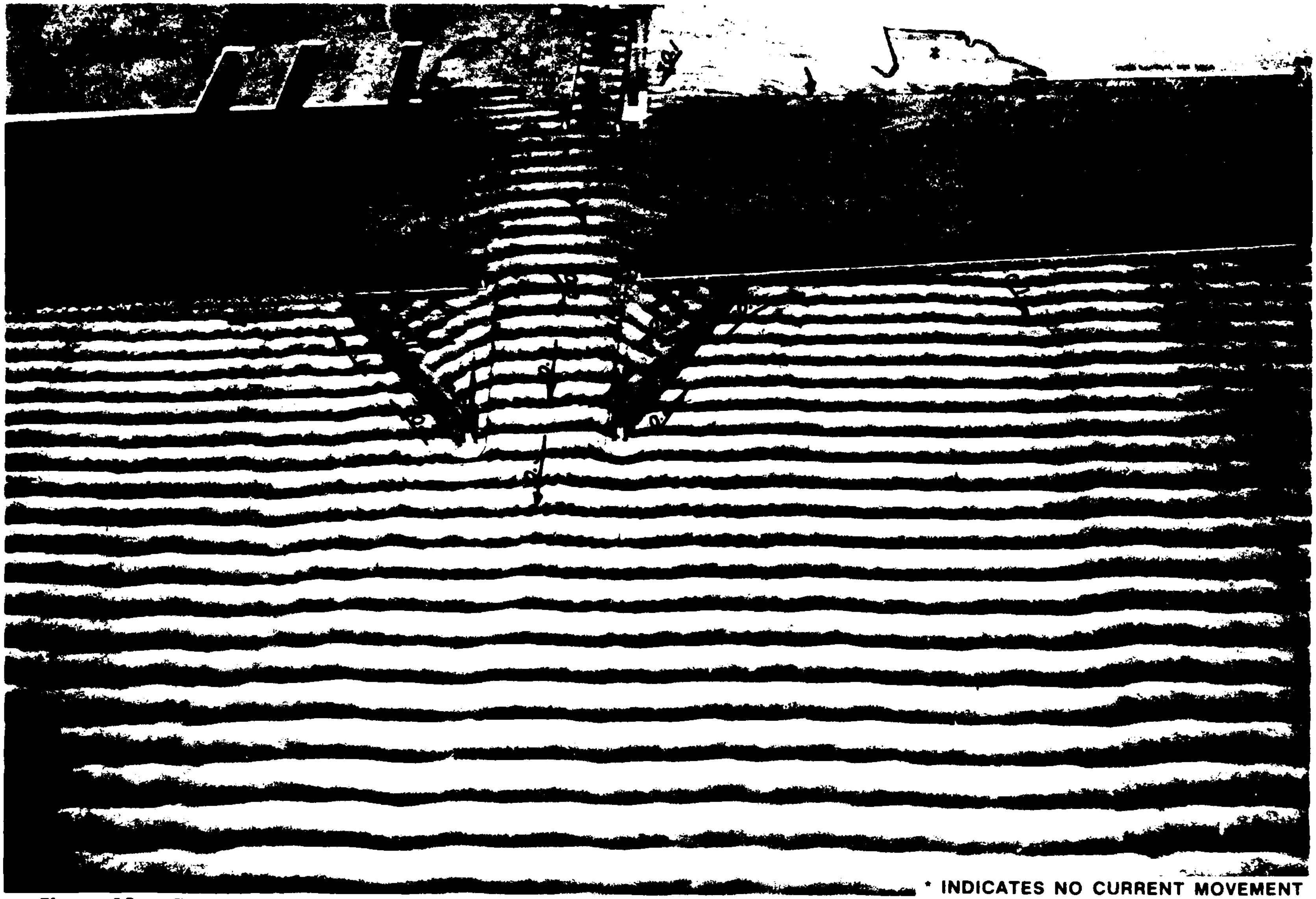



Photo 13. Typical wave patterns, current patterns, and current magnitudes (prototype feet per second) for existing conditions; 6-sec, 5.6-ft waves from 326 deg; 0.0-ft swl; river discharge 800 cfs

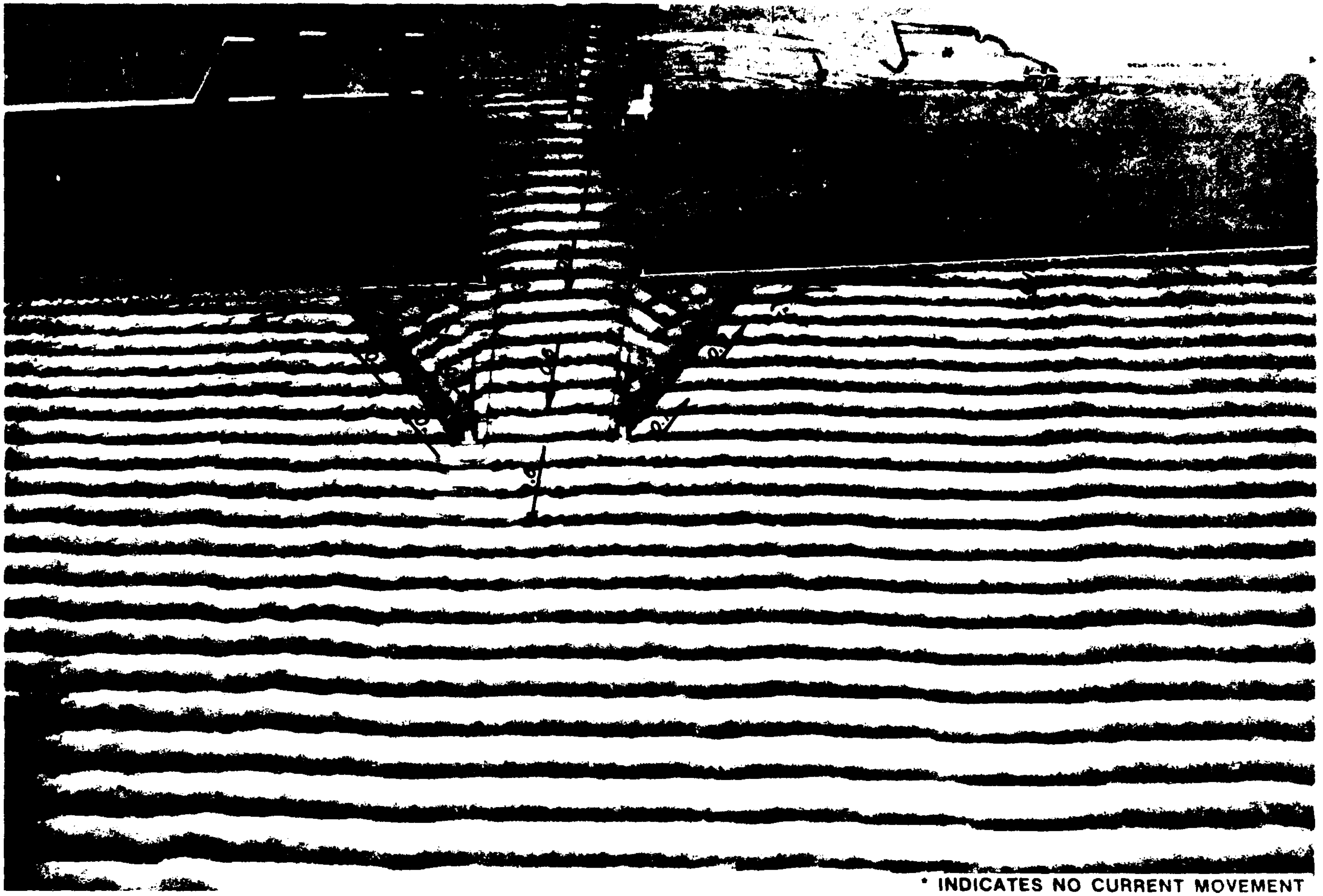



Photo 14. Typical wave patterns, current patterns, and current magnitudes (prototype feet per second) for existing conditions; 6-sec, 5.6-ft waves from 326 deg; 0.0-ft swl; river discharge 8,000 cfs

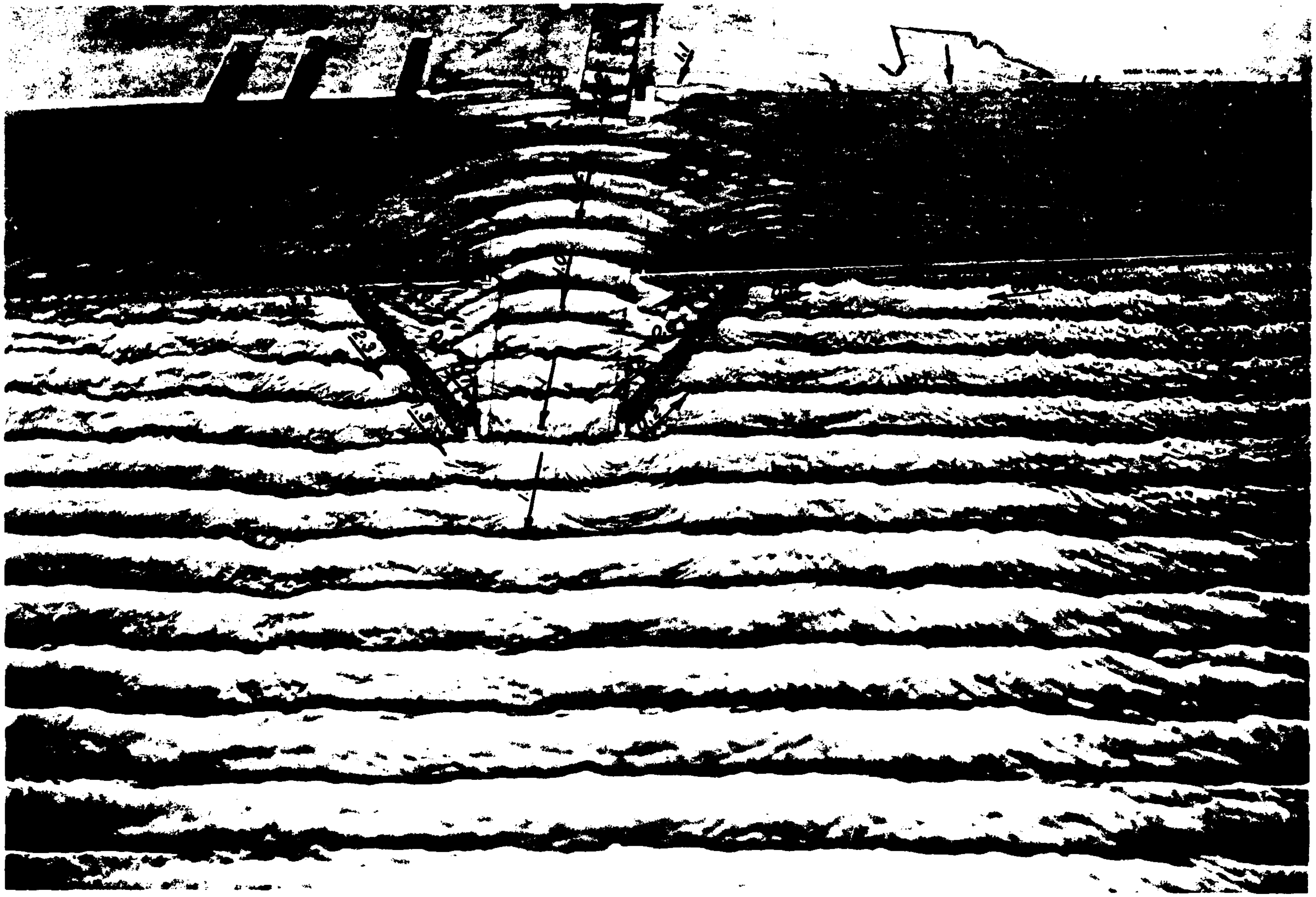


Photo 15. Typical wave patterns, current patterns, and current magnitudes (prototype feet per second) for existing conditions; 9-sec, 11.9-ft waves from 326 deg; 0.0-ft swl; river discharge 800 cfs

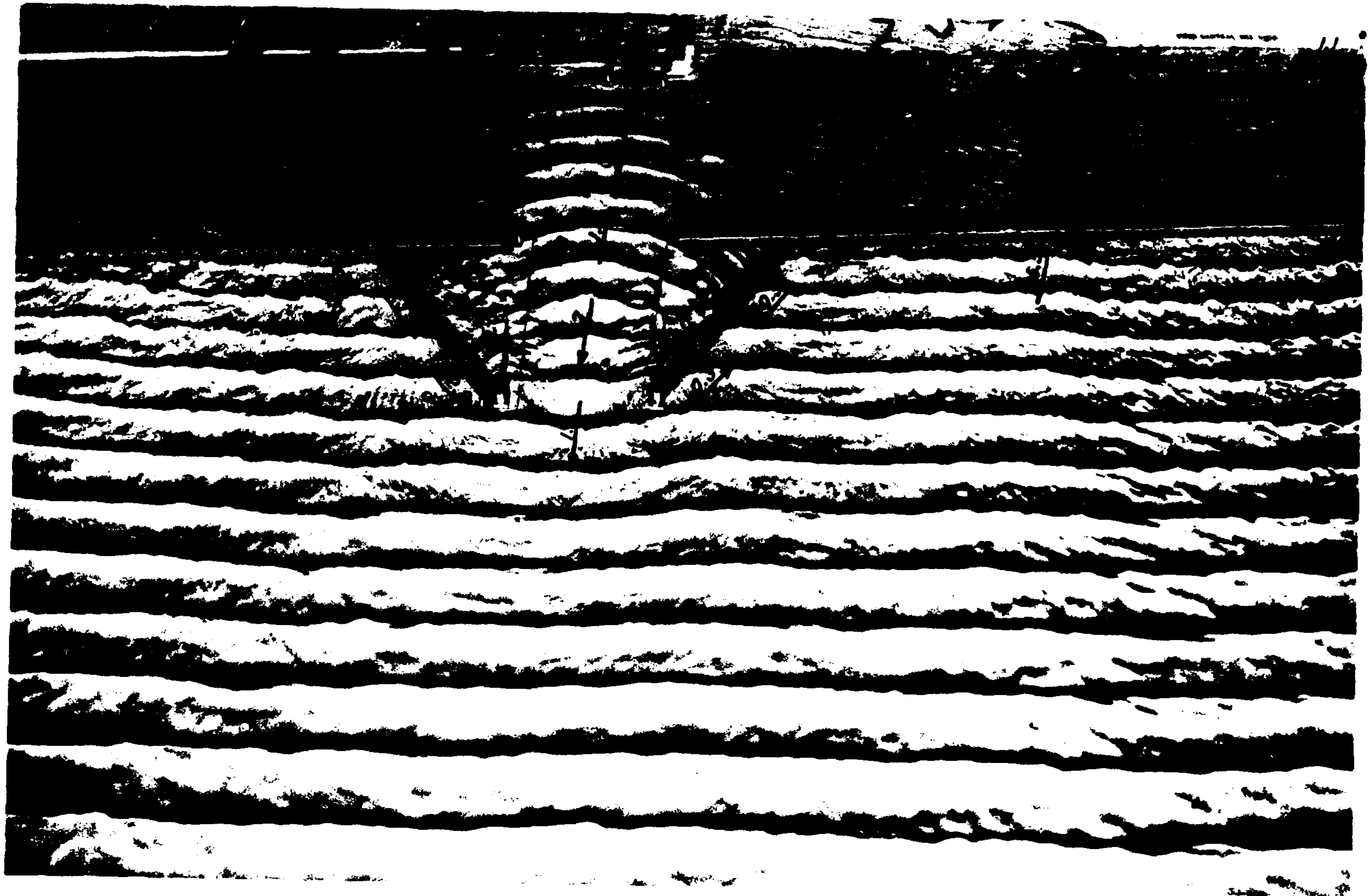
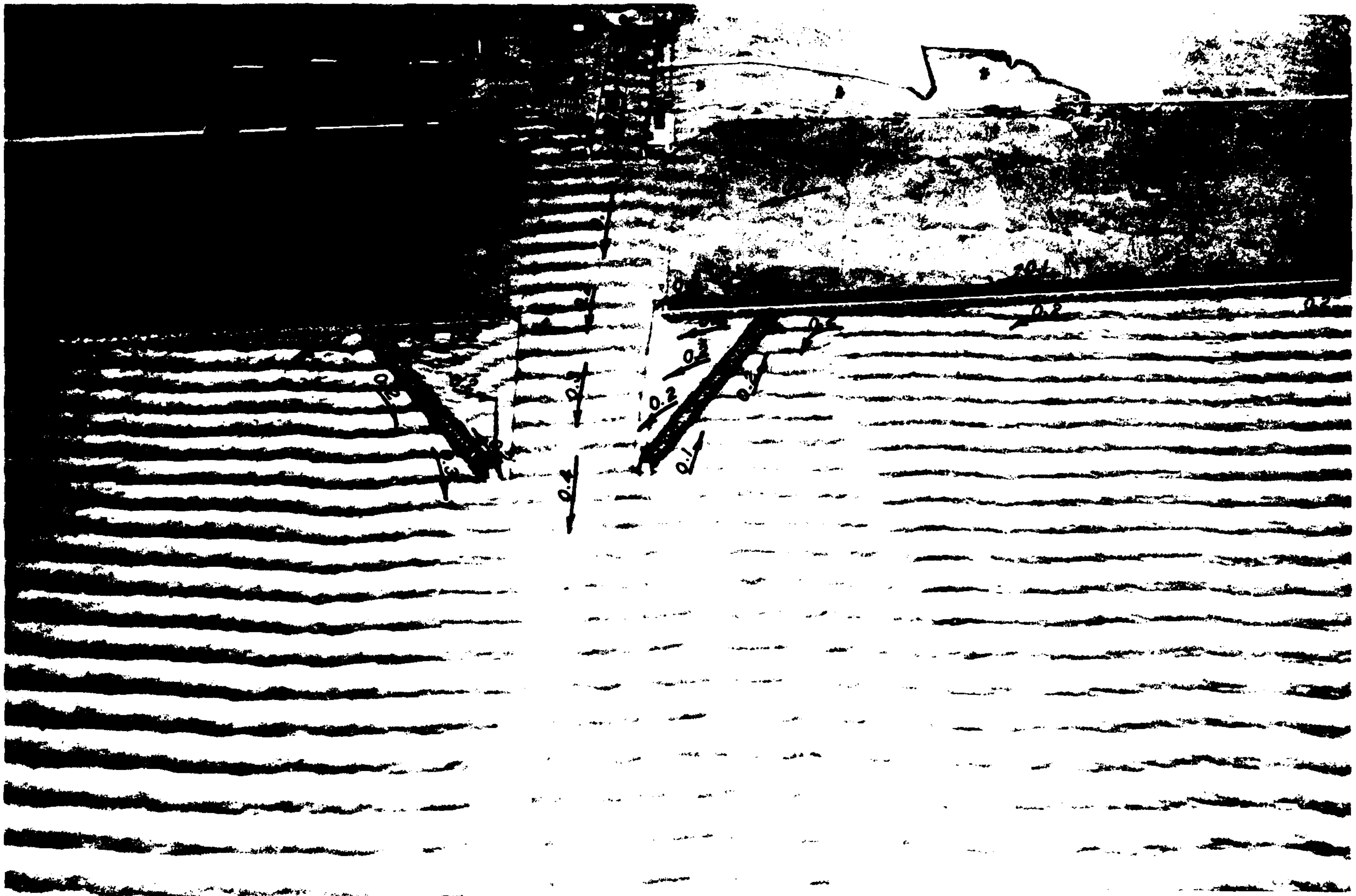


Photo 16. Typical wave patterns, current patterns, and current magnitudes (prototype feet per second) for existing conditions; 9-sec, 11.9-ft waves from 326 deg; 0.0-ft swl; river discharge 8,000 cfs



* INDICATES NO CURRENT MOVEMENT

Photo 17. Typical wave patterns, current patterns, and current magnitudes (prototype feet per second) for existing conditions; 6-sec, 5.6-ft waves from 326 deg; +2.6 ft swl; river discharge 800 cfs

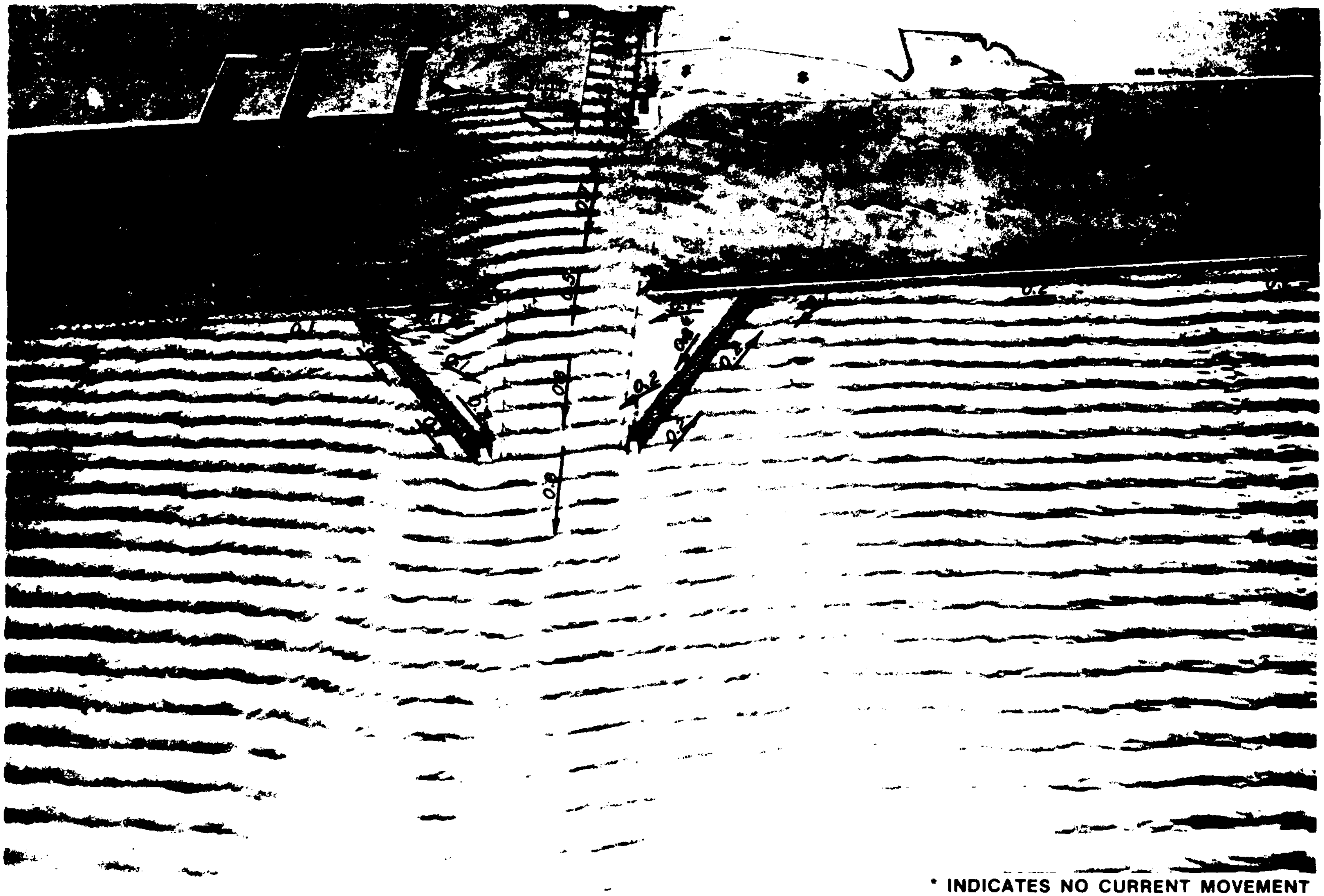



Photo 18. Typical wave patterns, current patterns, and current magnitudes (prototype feet per second) for existing conditions; 6-sec, 5.6-ft waves from 326 deg; +2.6 ft swl; river discharge 8,000 cfs

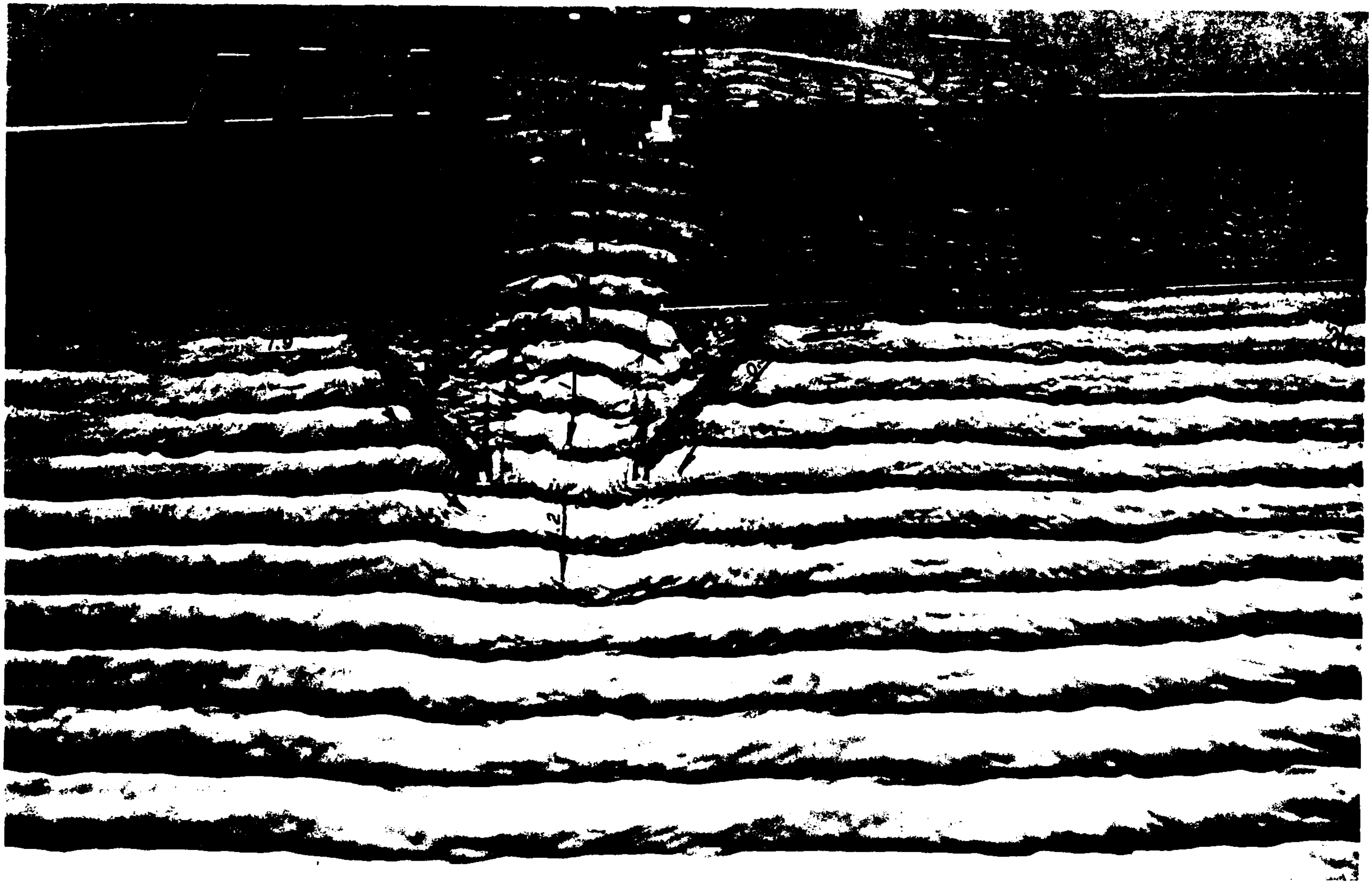


Photo 19. Typical wave patterns, current patterns, and current magnitudes (prototype feet per second) for existing conditions; 9-sec, 11.9-ft waves from 326 deg; +2.6 ft swl; river discharge 800 cfs

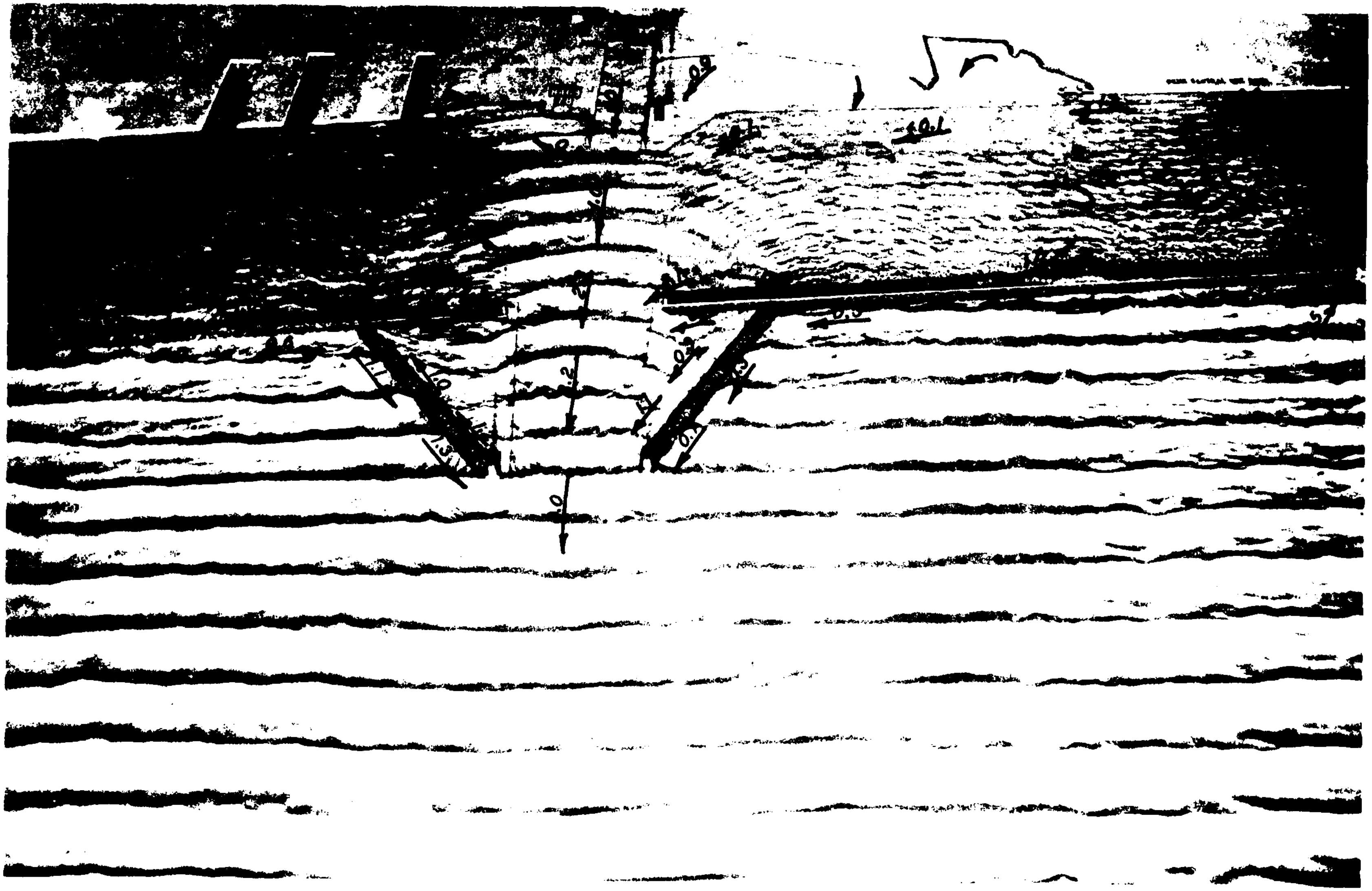


Photo 20. Typical wave patterns, current patterns, and current magnitudes (prototype feet per second) for existing conditions; 9-sec, 11.9-ft waves from 326 deg; +2.6 ft swl; river discharge 8,000 cfs

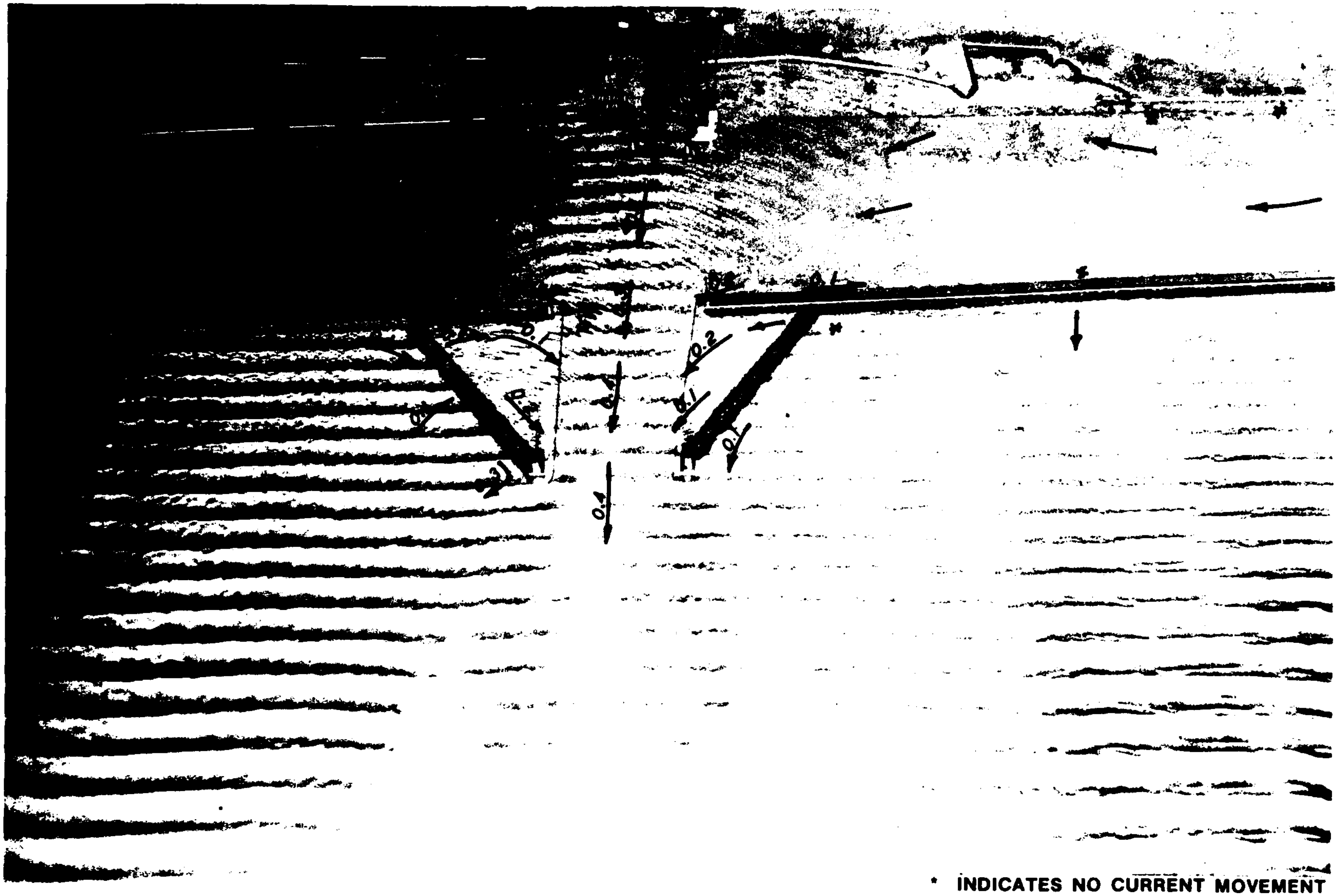



Photo 21. Typical wave patterns, current patterns, and current magnitudes (prototype feet per second) for existing conditions; 6-sec, 5.6-ft waves from 326 deg; +4.8 ft swl; river discharge 800 cfs

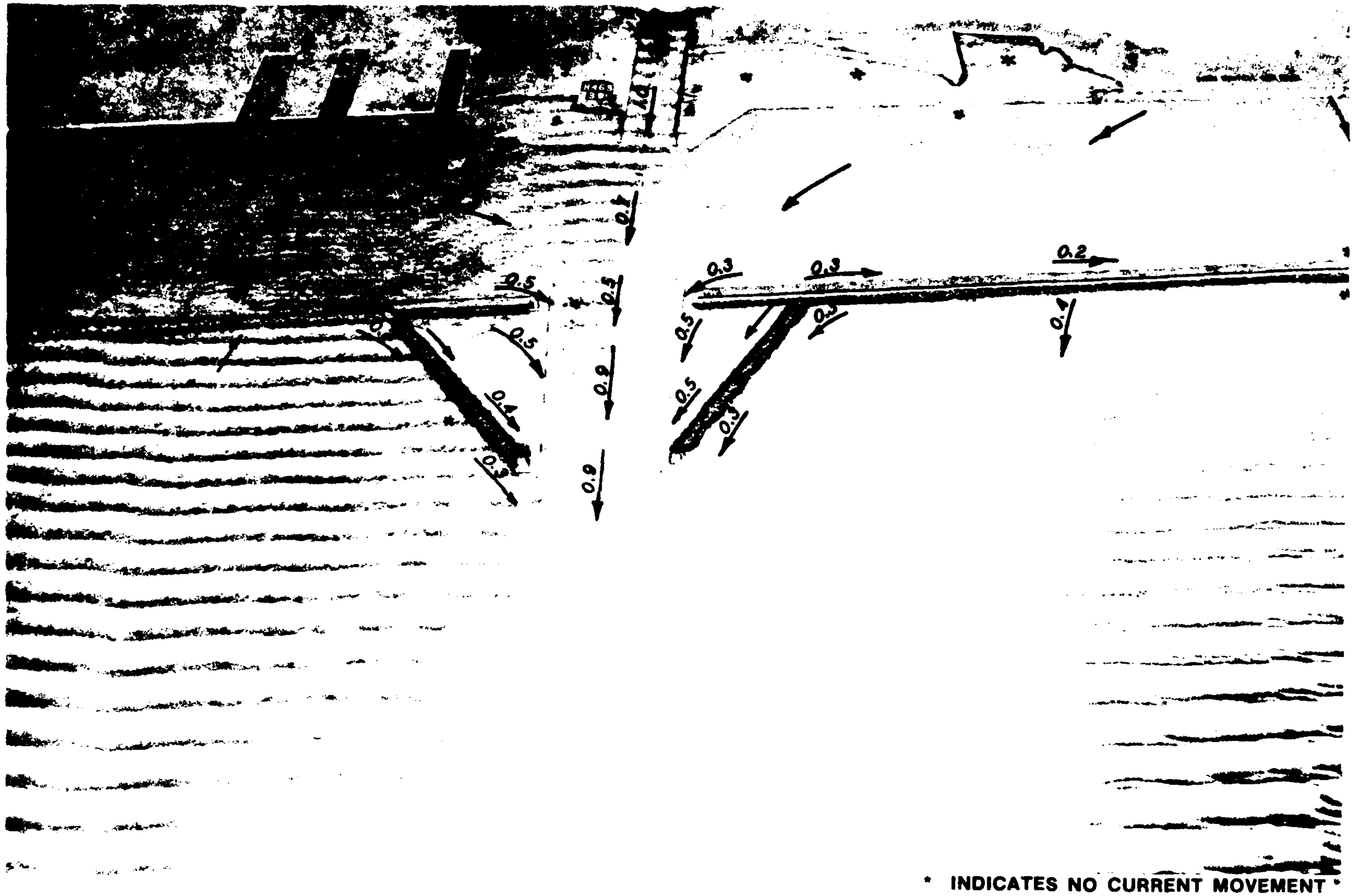



Photo 22. Typical wave patterns, current patterns, and current magnitudes (prototype feet per second) for existing conditions; 6-sec, 5.6-ft waves from 326 deg; +4.8 ft swl; river discharge 8,000 cfs

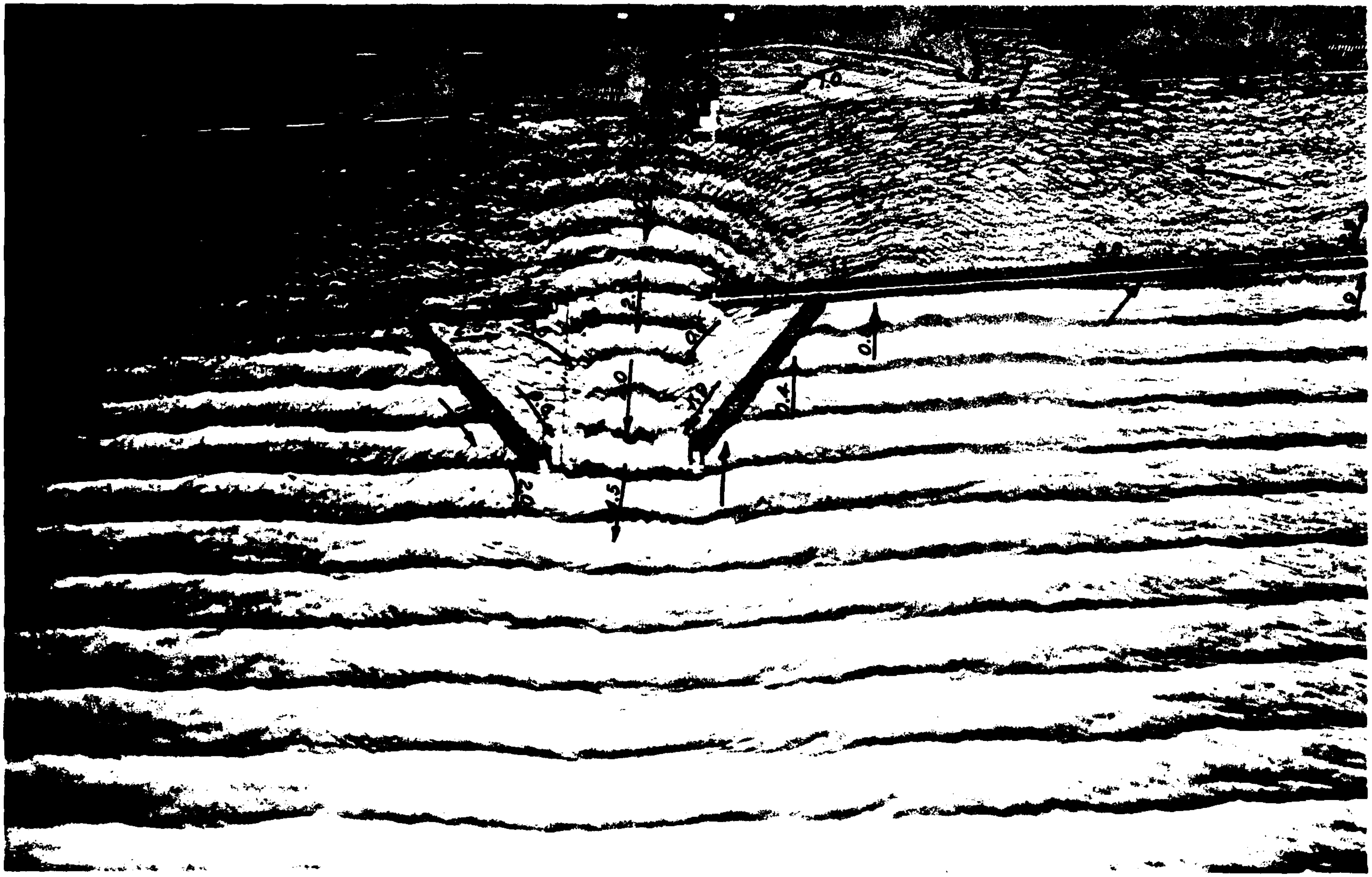
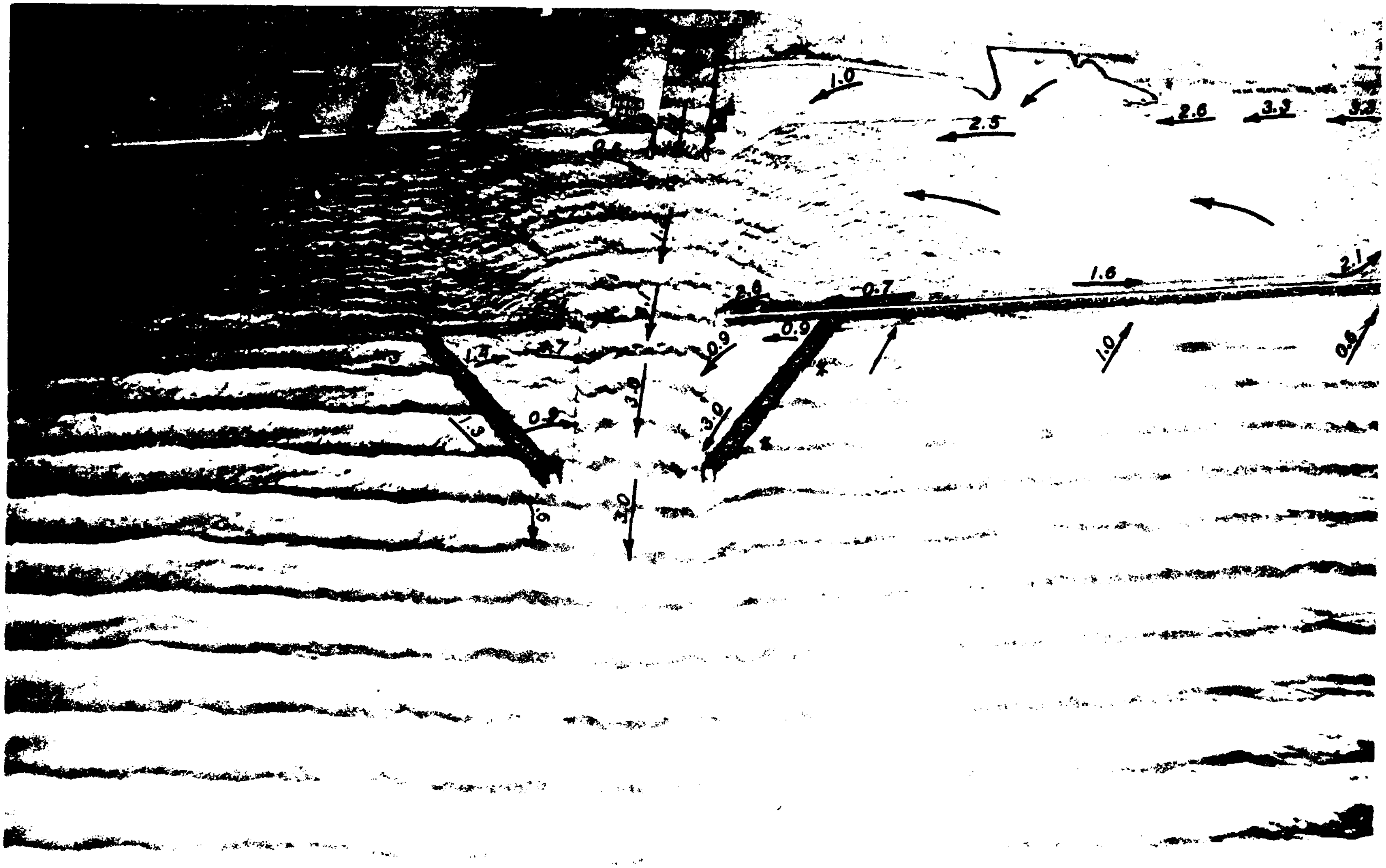


Photo 23. Typical wave patterns, current patterns, and current magnitudes (prototype feet per second) for existing conditions; 9-sec, 11.9-ft waves from 326 deg; +4.8 ft swl; river discharge 800 cfs




* INDICATES NO CURRENT MOVEMENT

Photo 24. Typical wave patterns, current patterns, and current magnitudes (prototype feet per second) for existing conditions; 9-sec, 11.9-ft waves from 326 deg; +4.8 ft swl; river discharge 8,000 cfs

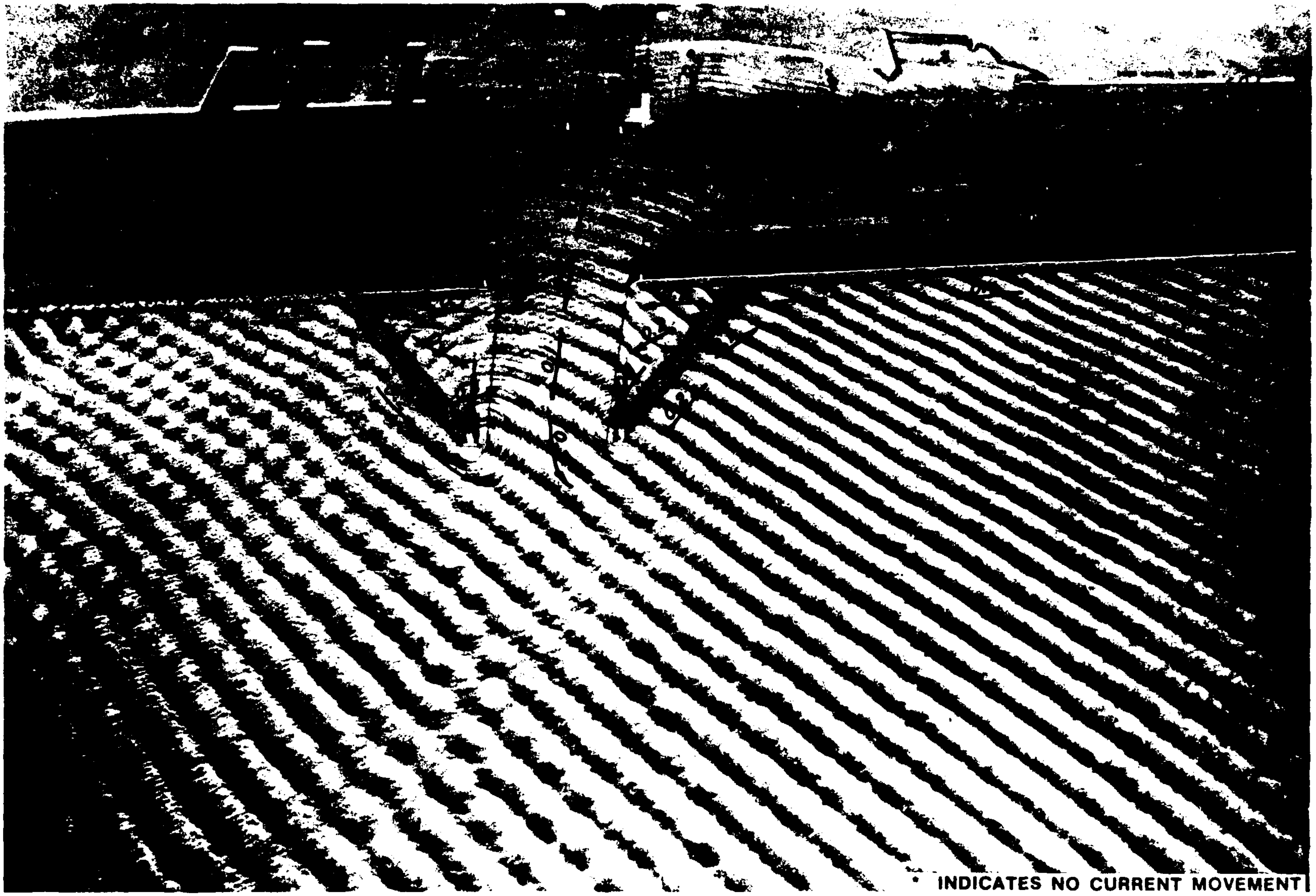



Photo 25. Typical wave patterns, current patterns, and current magnitudes (prototype feet per second) for existing conditions; 6-sec, 4.7-ft waves from 17 deg; 0.0-ft swl; river discharge 800 cfs

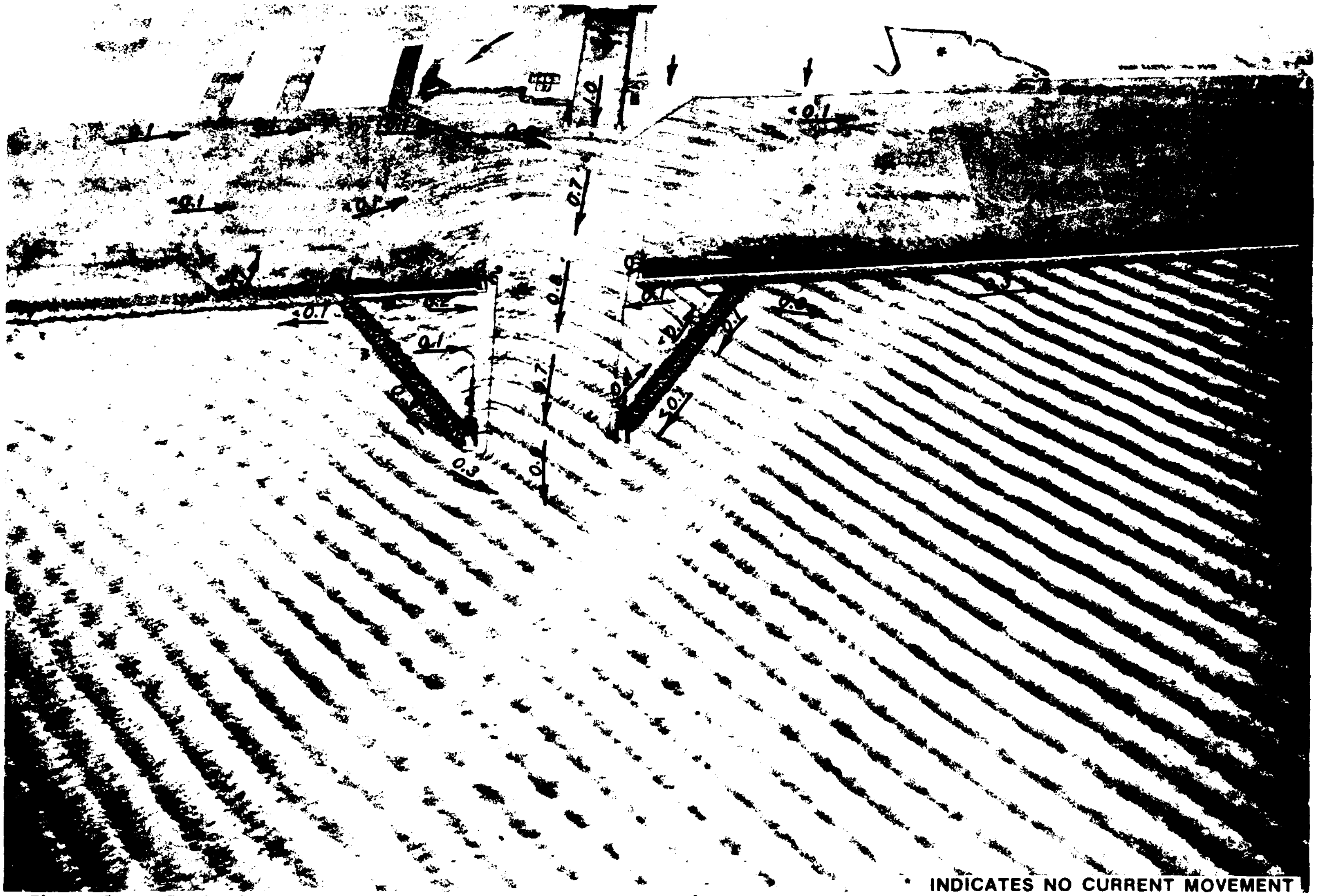



Photo 26. Typical wave patterns, current patterns, and current magnitudes (prototype feet per second) for existing conditions; 6-sec, 4.7-ft waves from 17 deg; 0.0-ft swl; river discharge 8,000 cfs


Photo 27. Typical wave patterns, current patterns, and current magnitudes (prototype feet per second) for existing conditions; 8-sec, 9.8-ft waves from 17 deg; 0.0-ft swl; river discharge 800 cfs

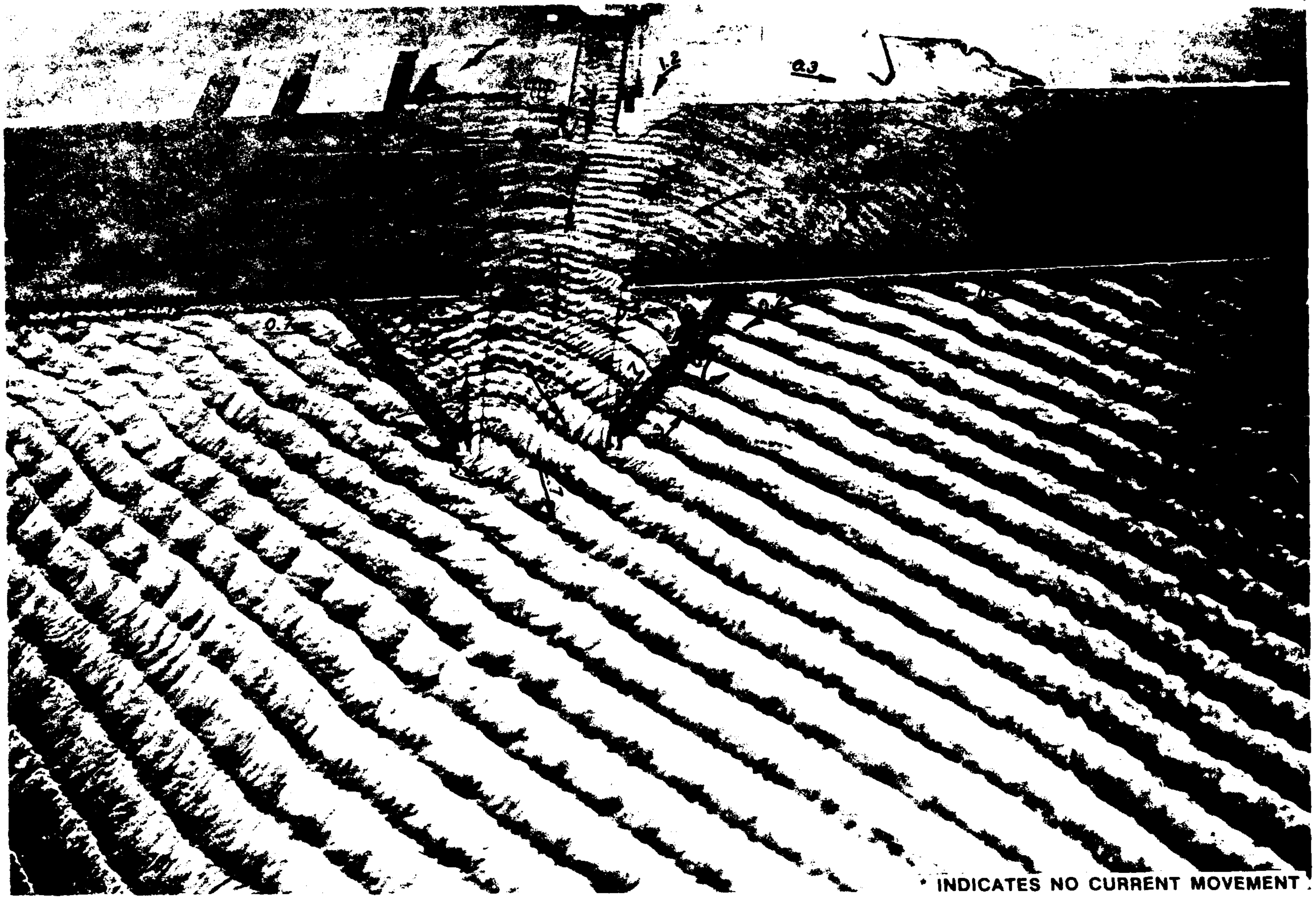



Photo 28. Typical wave patterns, current patterns, and current magnitudes (prototype feet per second) for existing conditions; 8-sec, 9.8-ft waves from 17 deg; 0.0-ft swl; river discharge 8,000 cfs

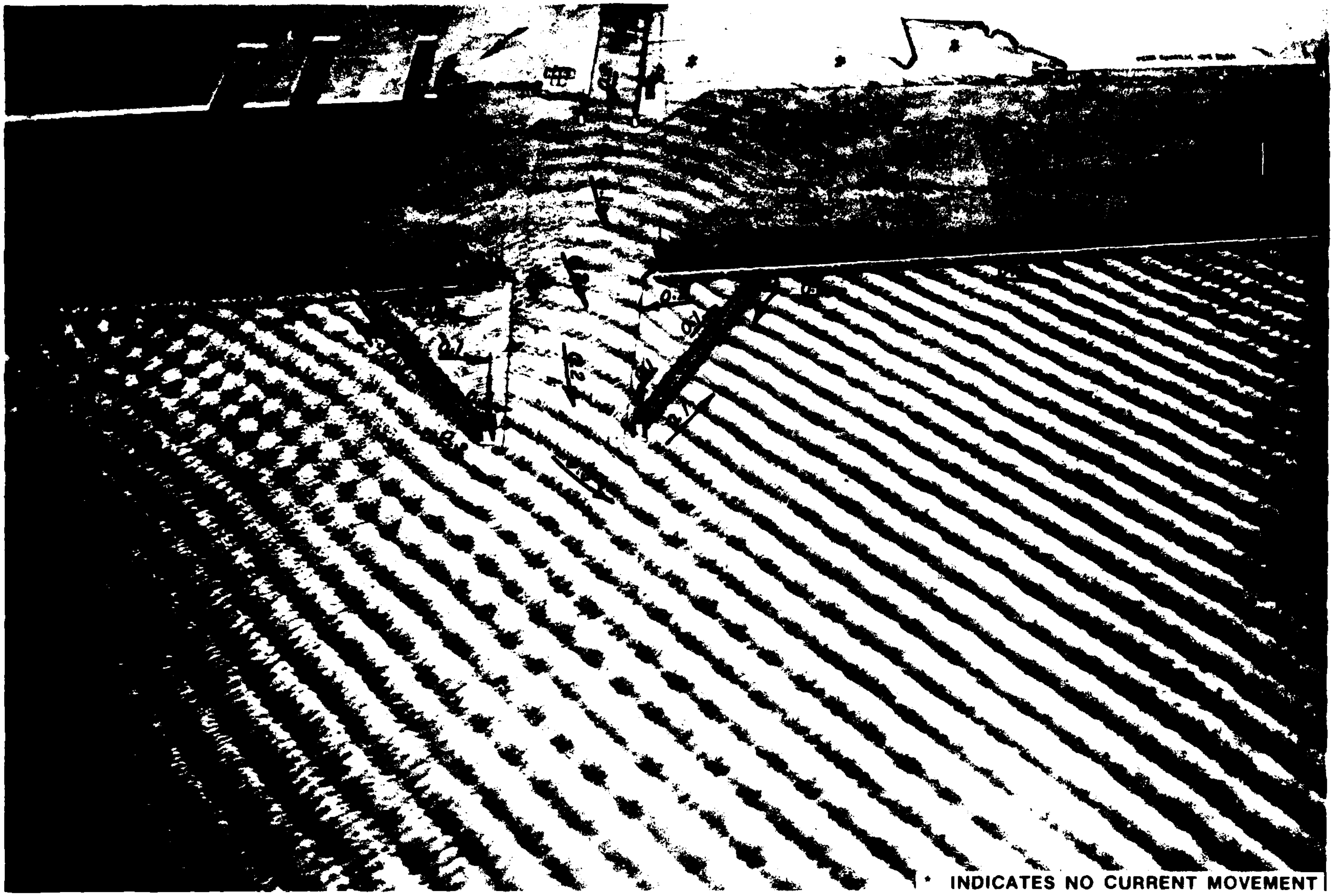



Photo 29. Typical wave patterns, current patterns, and current magnitudes (prototype feet per second) for existing conditions; 6-sec, 4.7-ft waves from 17 deg; +2.6 ft swl; river discharge 800 cfs

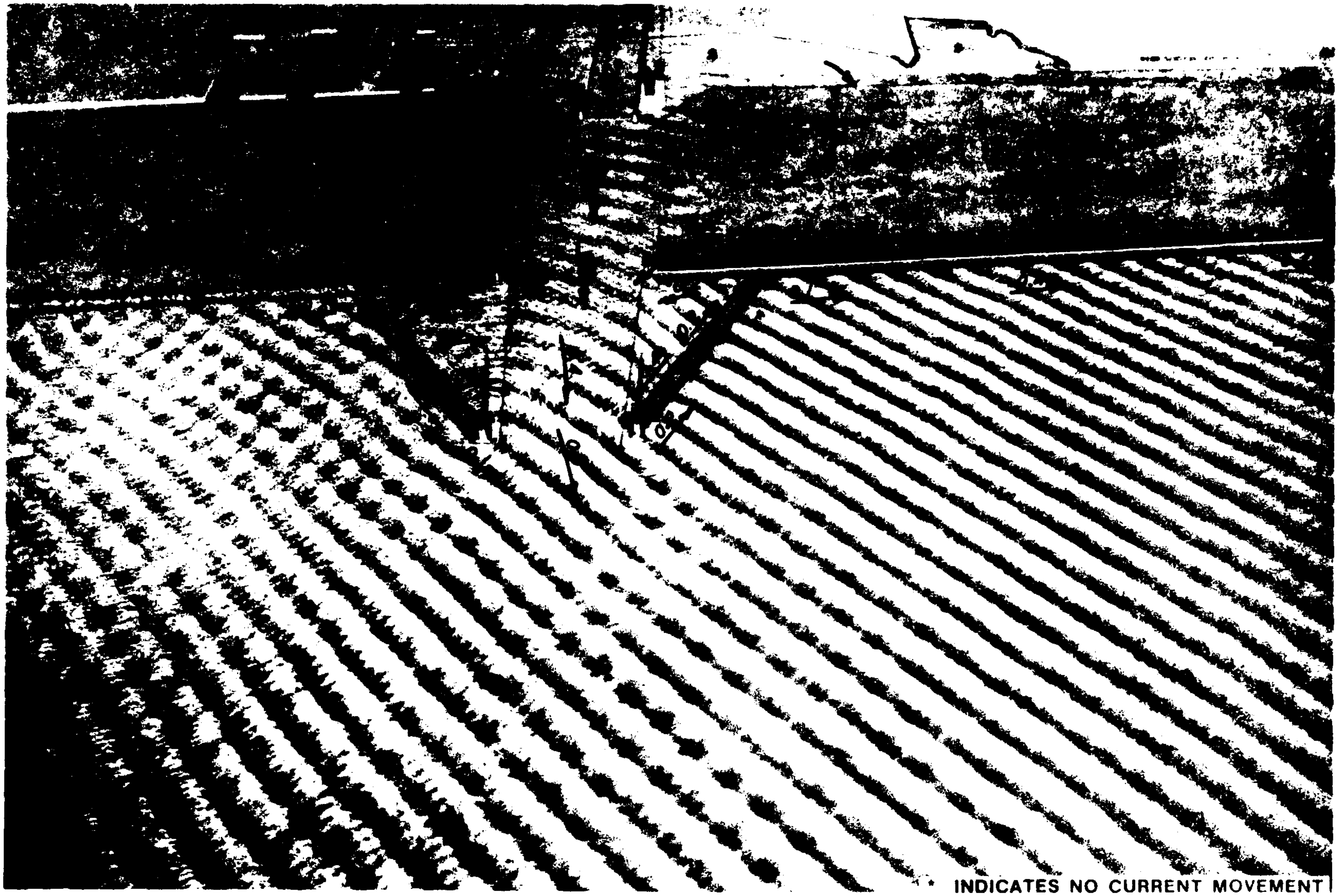



Photo 30. Typical wave patterns, current patterns, and current magnitudes (prototype feet per second) for existing conditions; 6-sec, 4.7-ft waves from 17 deg; +2.6 ft swl; river discharge 8,000 cfs

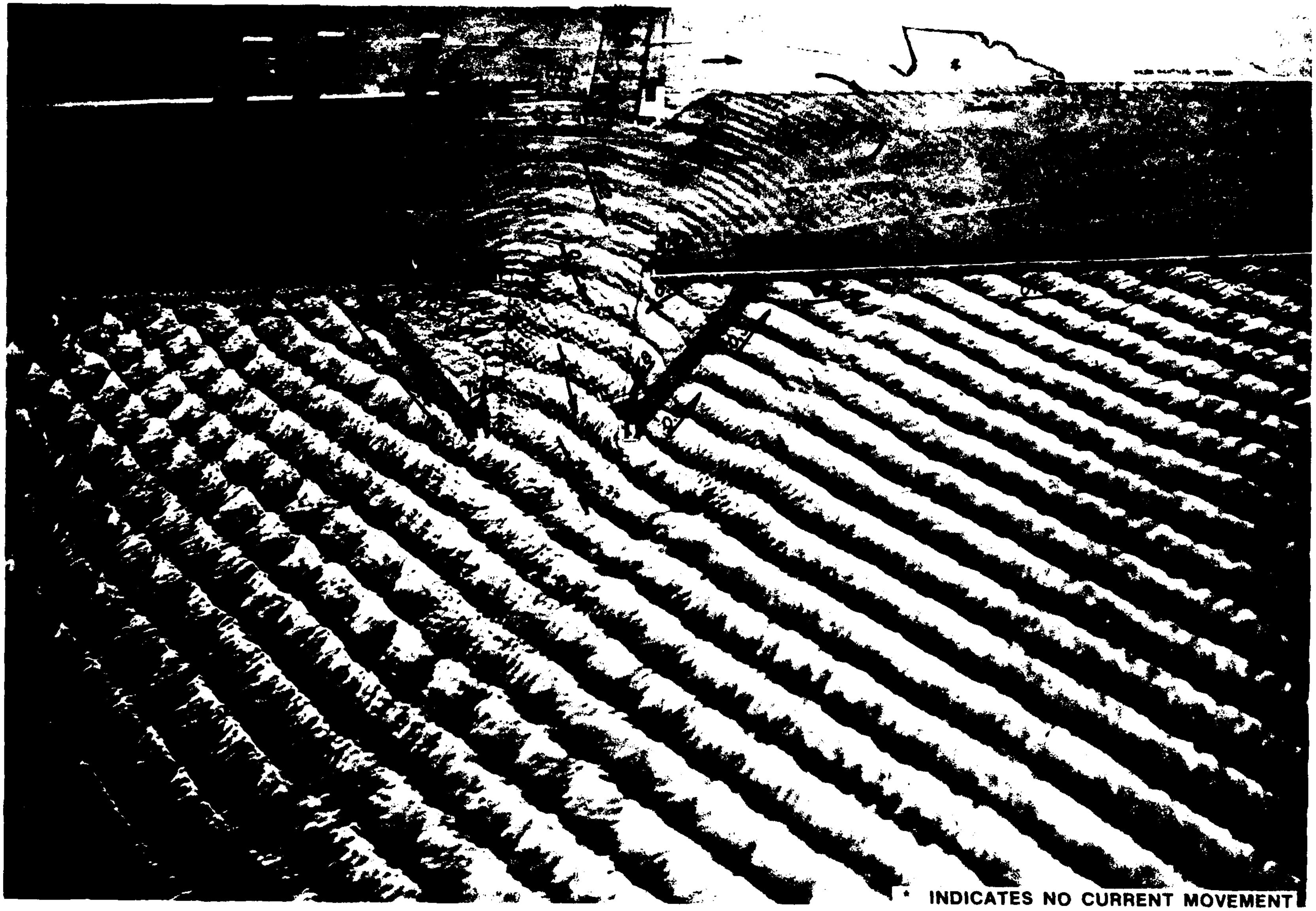



Photo 31. Typical wave patterns, current patterns, and current magnitudes (prototype feet per second) for existing conditions; 8-sec, 9.8-ft waves from 17 deg; +2.6 ft swl; river discharge 800 cfs

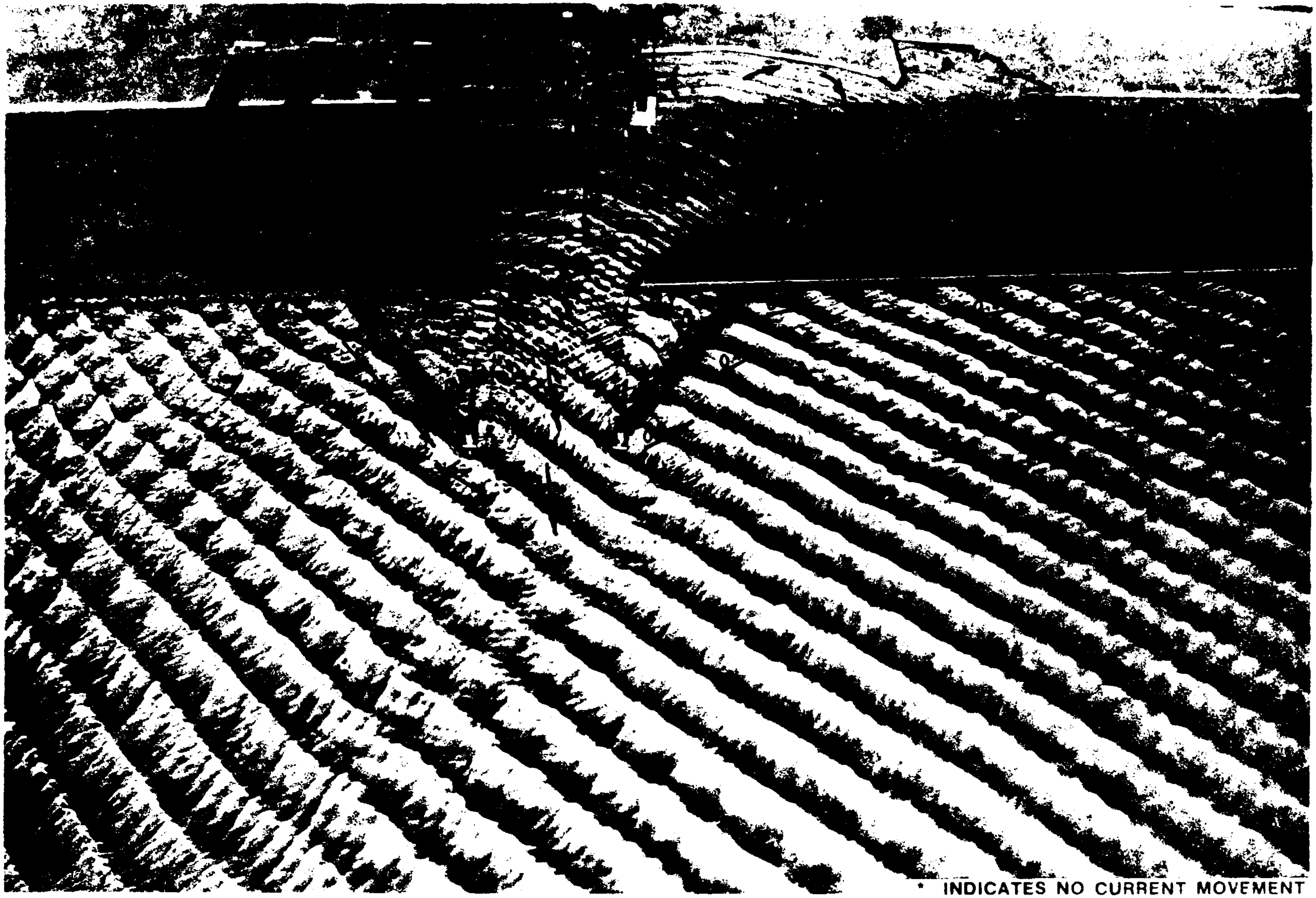



Photo 32. Typical wave patterns, current patterns, and current magnitudes (prototype feet per second) for existing conditions; 8-sec, 9.8-ft waves from 17 deg; +2.6 ft swl; river discharge 8,000 cfs

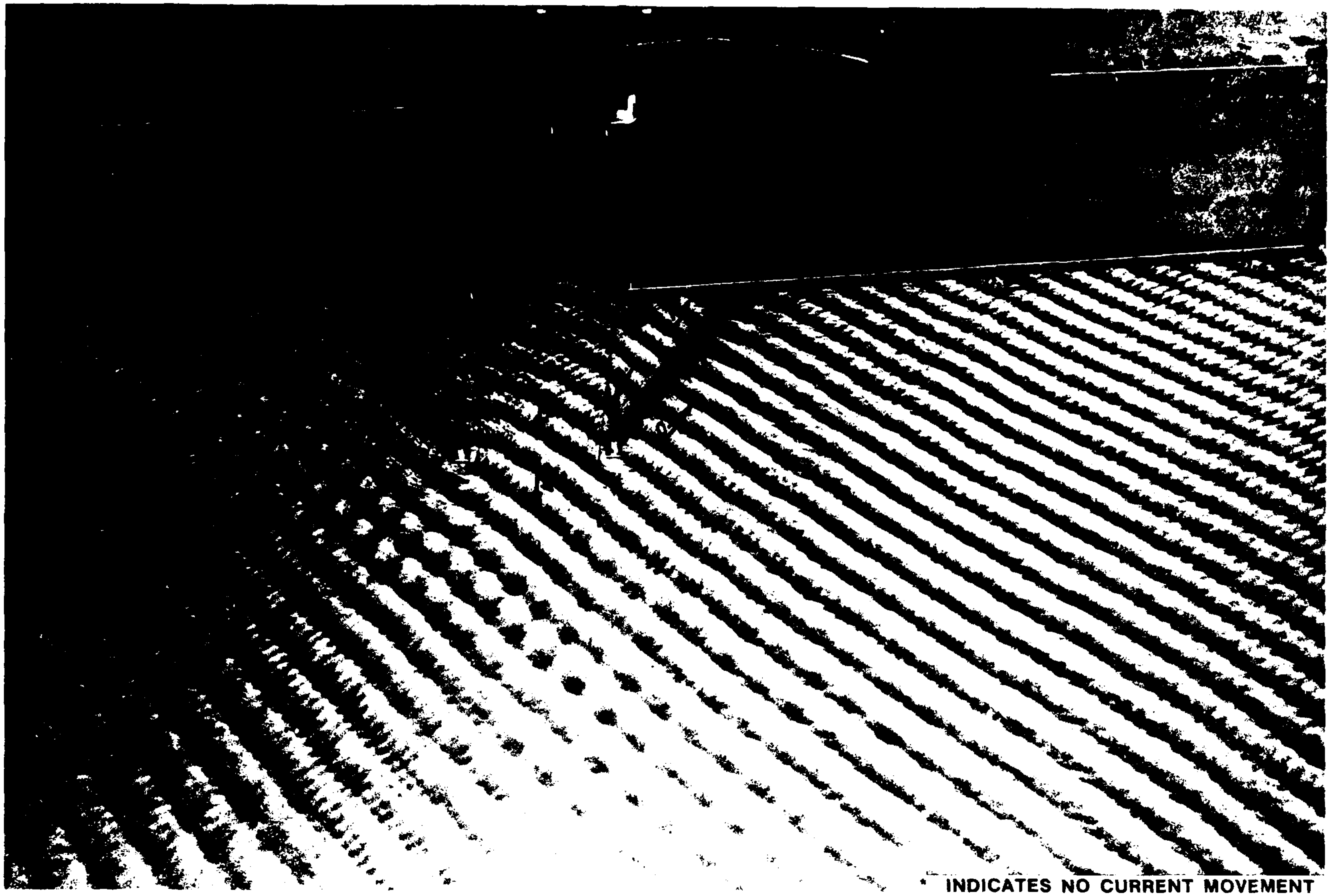



Photo 33. Typical wave patterns, current patterns, and current magnitudes (prototype feet per second) for existing conditions; 6-sec, 4.7-ft waves from 17 deg; +4.8 ft swl; river discharge 800 cfs

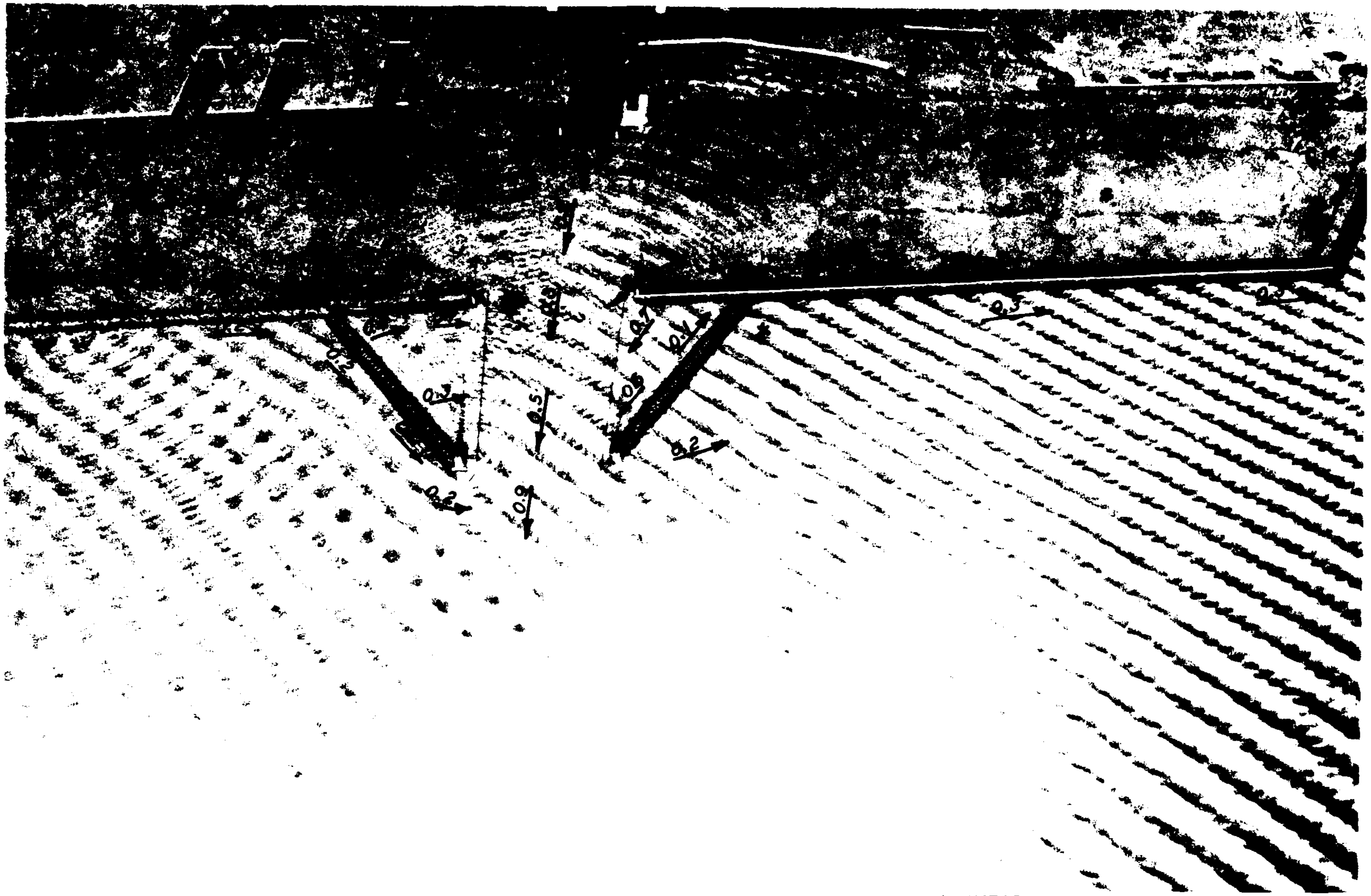



Photo 34. Typical wave patterns, current patterns, and current magnitudes (prototype feet per second) for existing conditions; 6-sec, 4.7-ft waves from 17 deg; +4.8 ft swl; river discharge 8,000 cfs

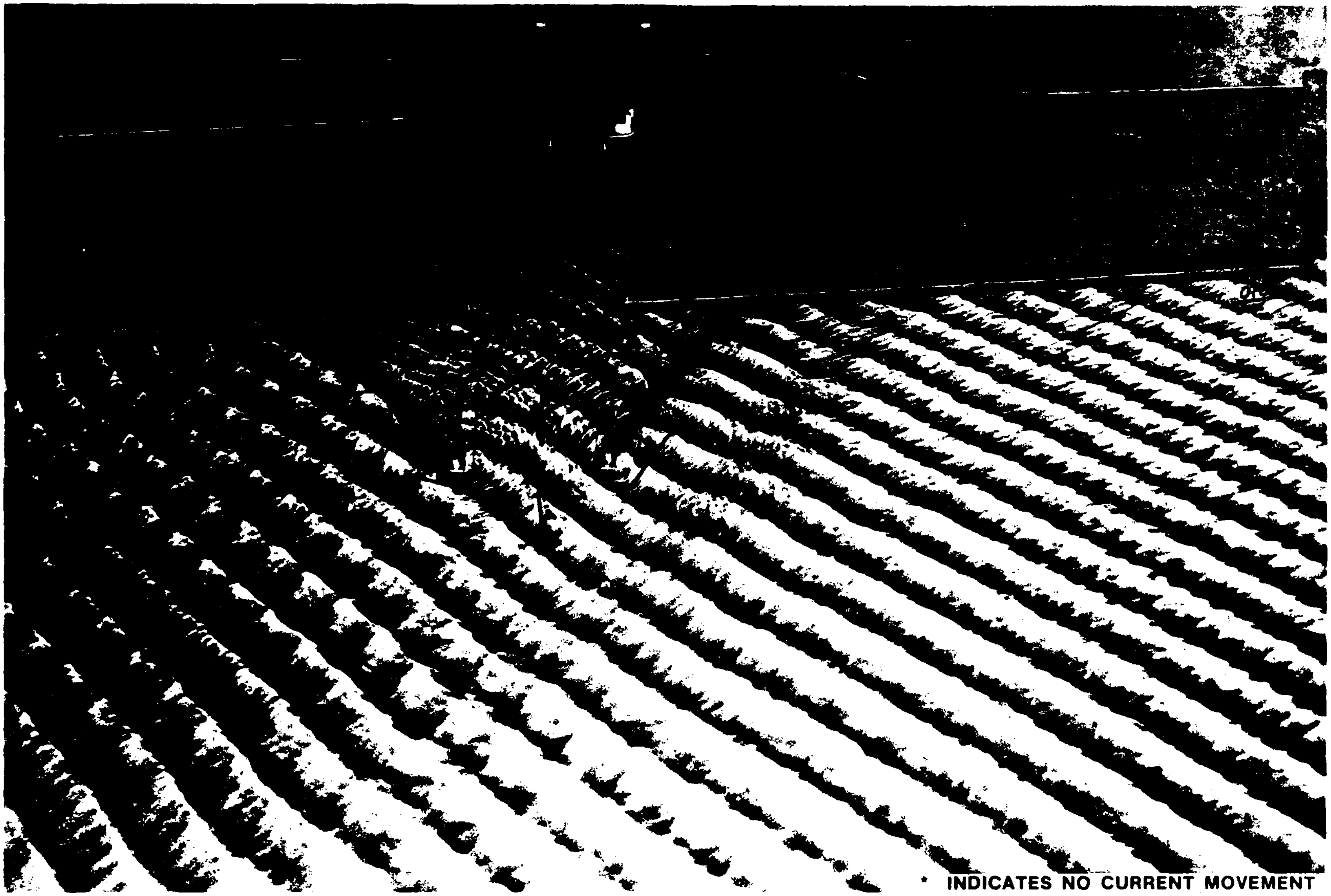



Photo 35. Typical wave patterns, current patterns, and current magnitudes (prototype feet per second) for existing conditions; 8-sec, 9.8-ft waves from 17 deg; +4.8 ft swl; river discharge 800 cfs

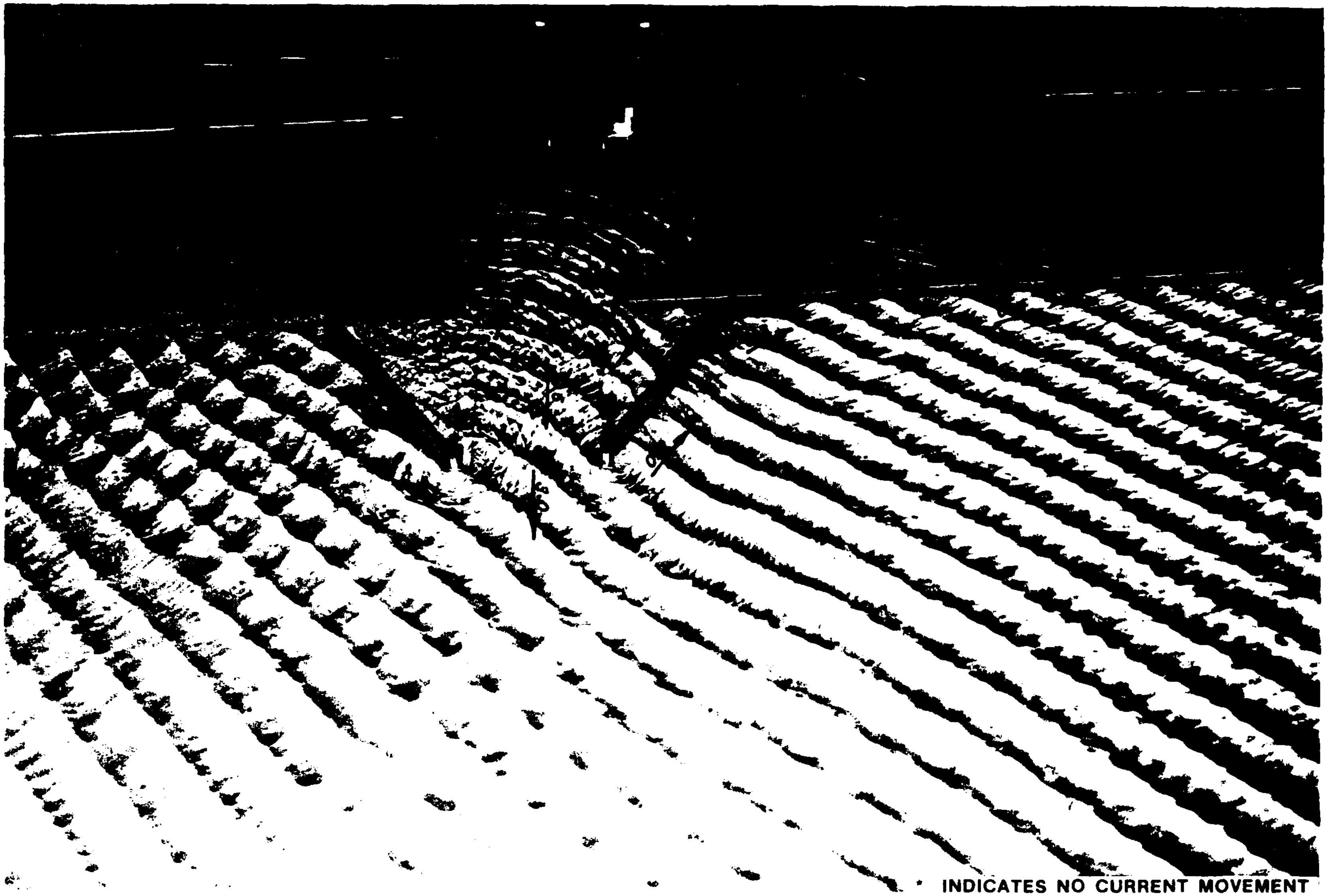



Photo 36. Typical wave patterns, current patterns, and current magnitudes (prototype feet per second) for existing conditions; 8-sec, 9.8-ft waves from 17 deg; +4.8 ft swl; river discharge 8,000 cfs

Photo 37. Model ore carrier preparing to enter the harbor

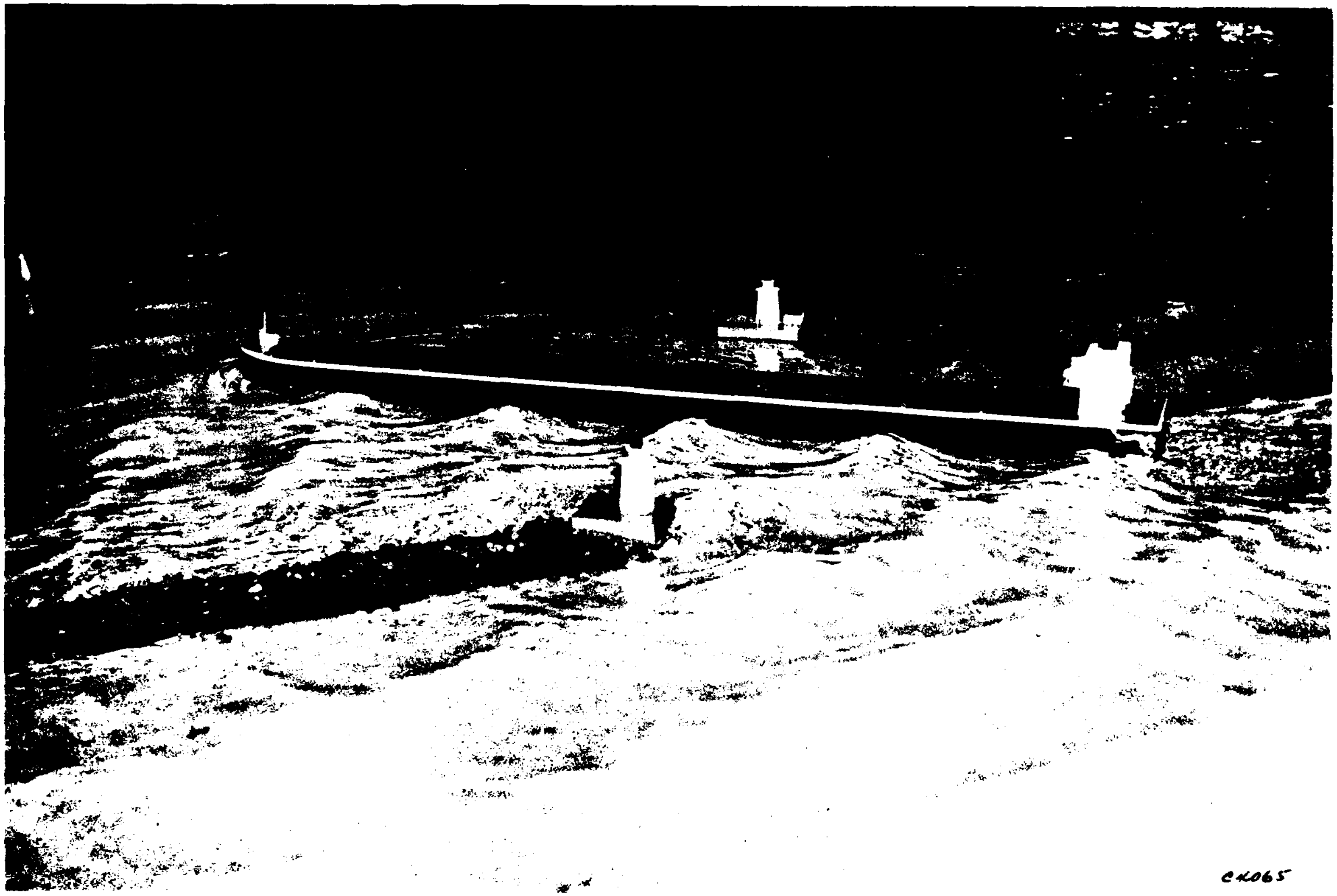
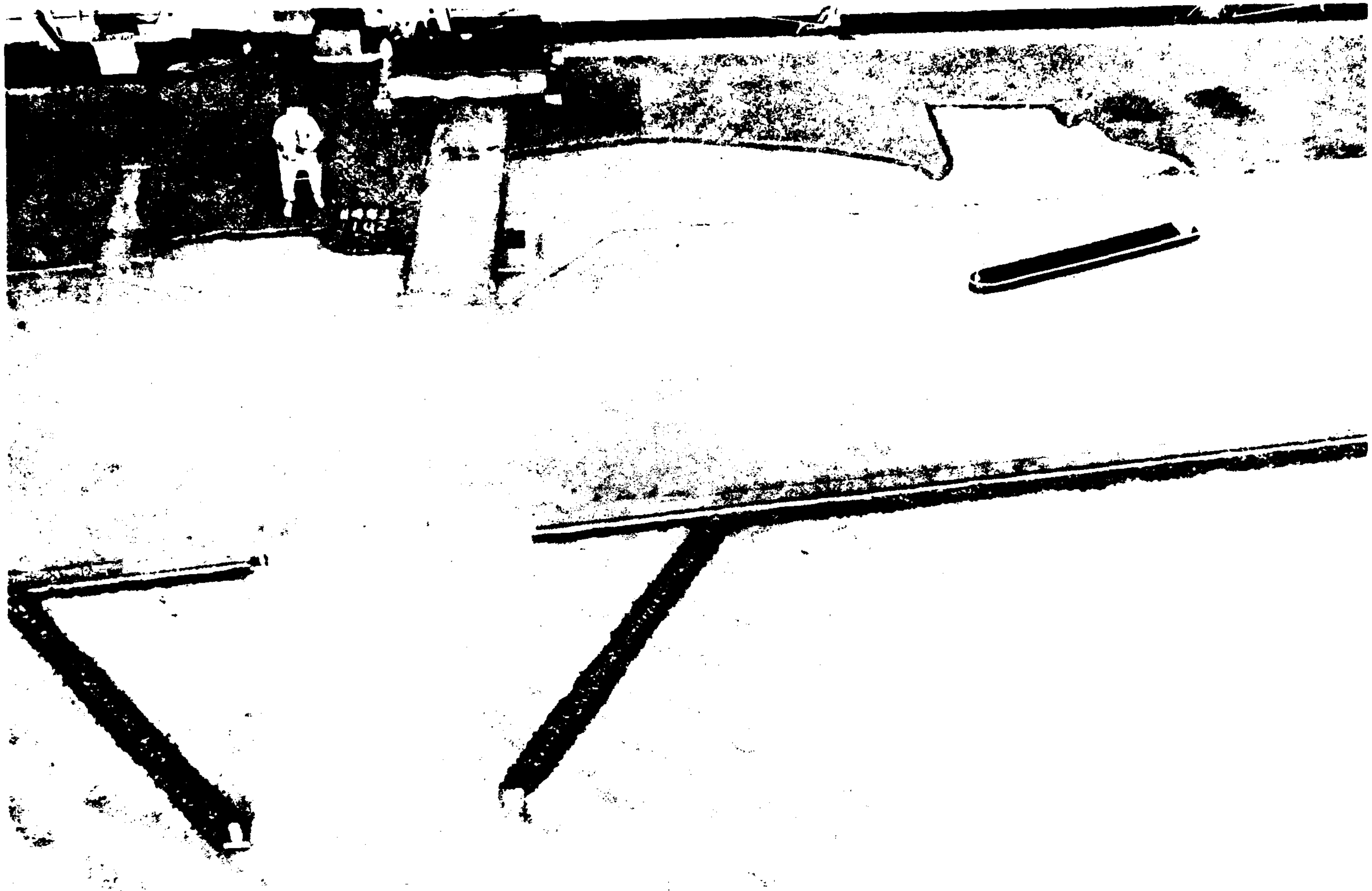



Photo 38. Model ore carrier entering present arrowhead entrance

Photo 39. Model ore carrier turning in harbor after entering



C4068

Photo 40. Model ore carrier backing to ore docks

Photo 41. CAPT William J. McSweeney docking the model ore carrier

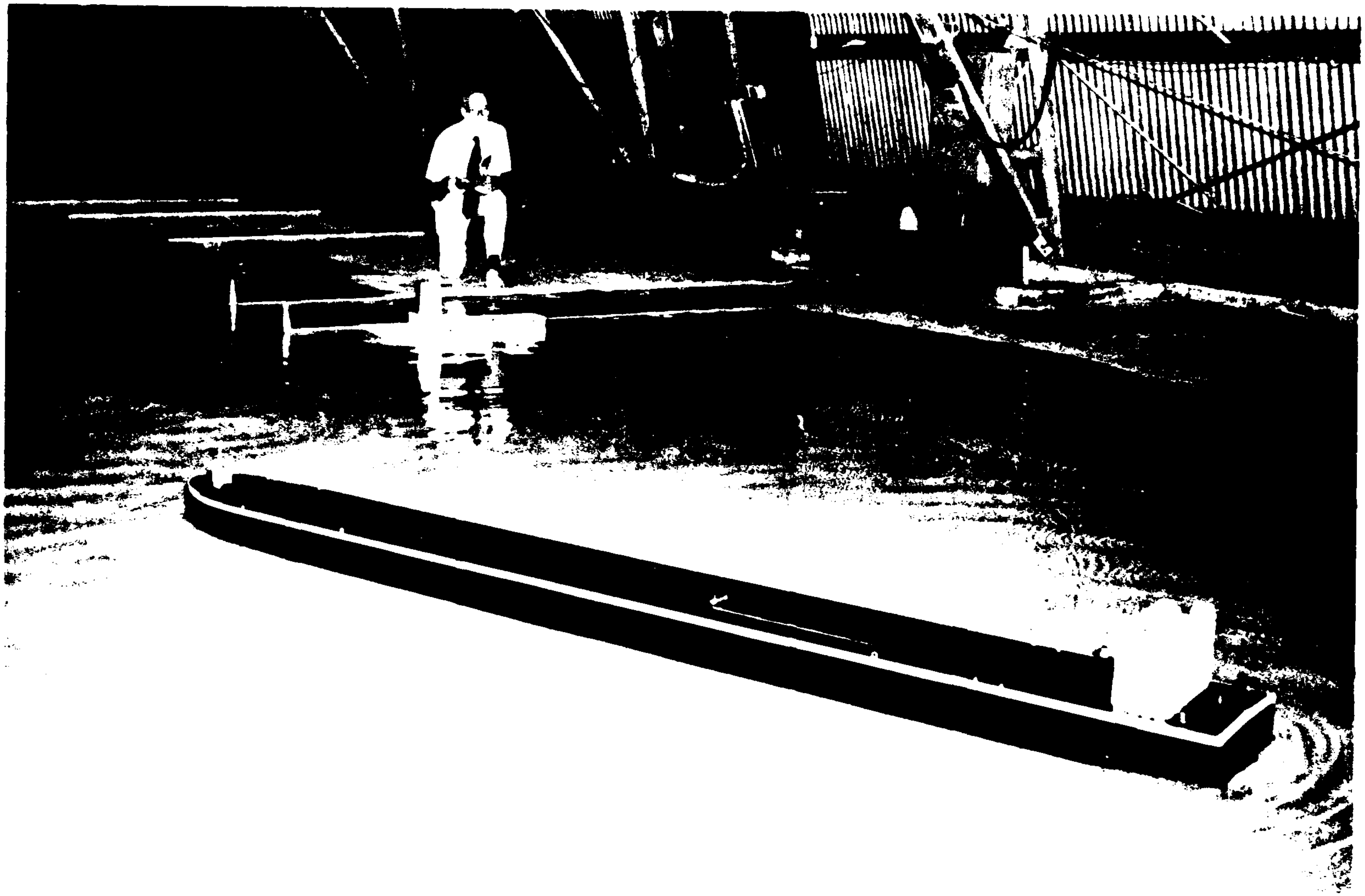
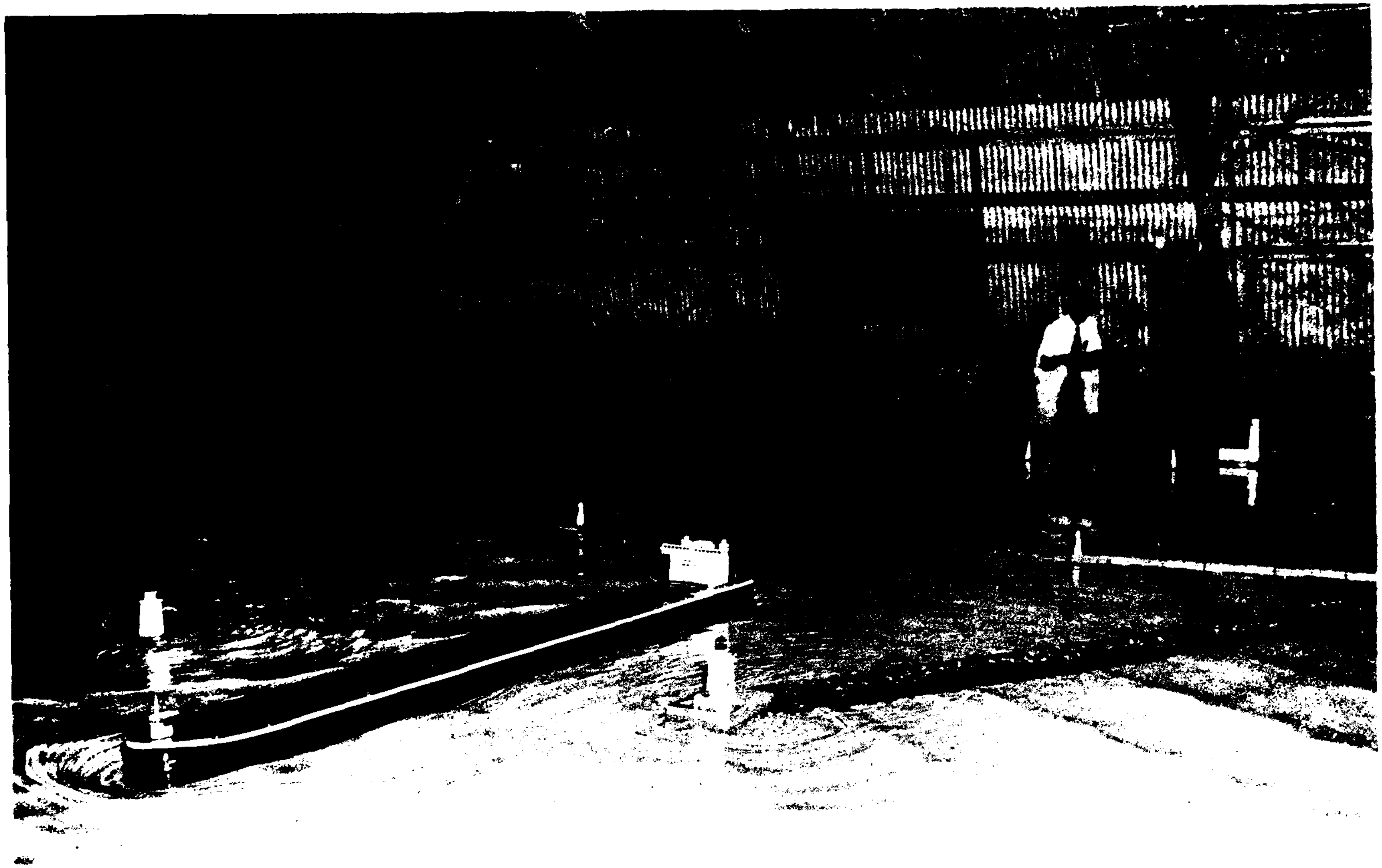


Photo 42. Model ore carrier preparing to leave the harbor



C4062

Photo 43. Model ore carrier exiting the existing main entrance


Photo 44. Typical wave patterns at the west entrance for Fair-Weather Plan 1; 9-sec, 11.9-ft waves from 326 deg; +2.6 ft swl; river discharge 800 cfs

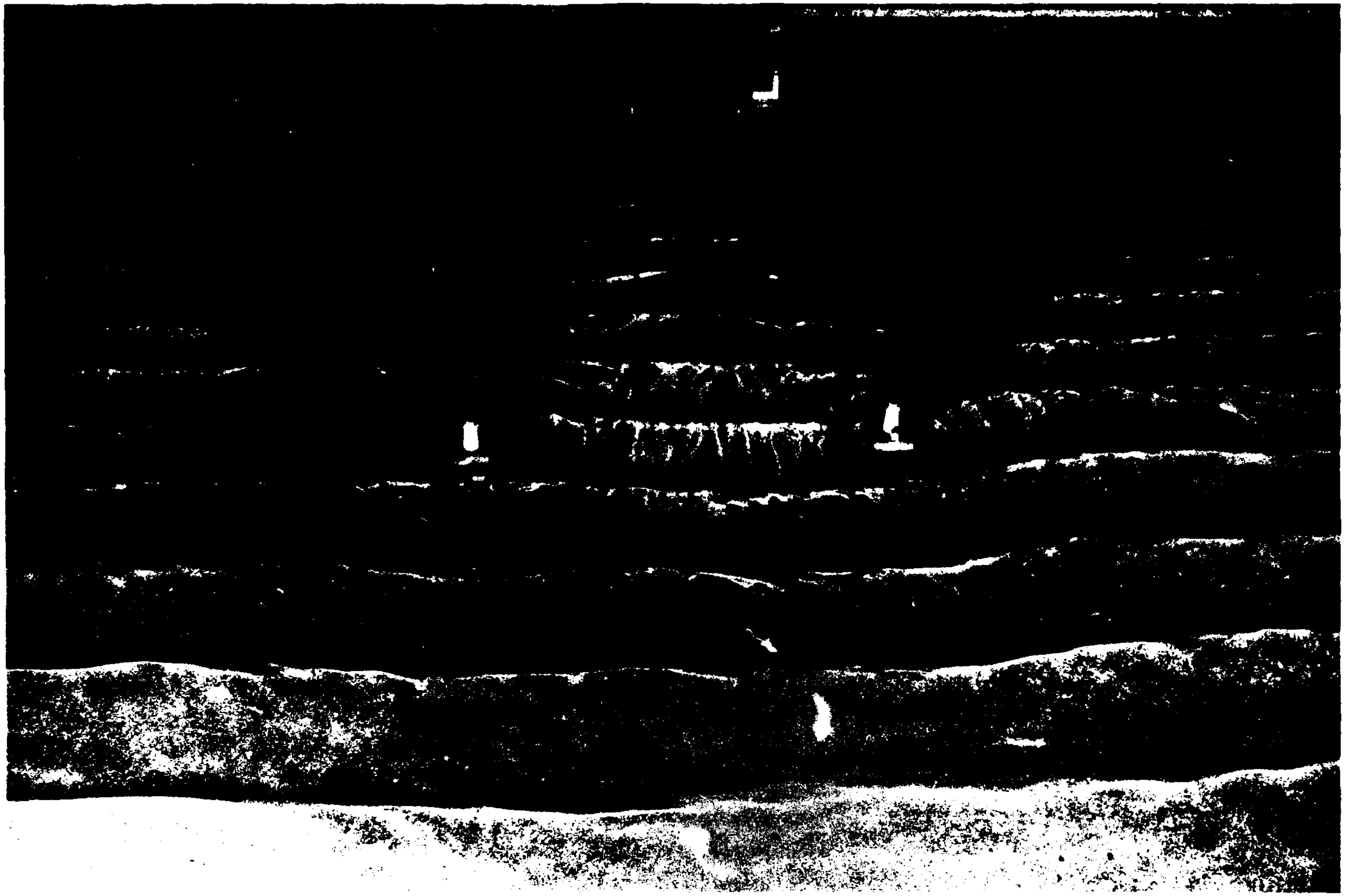


Photo 45. Typical wave patterns at the west entrance for Fair-Weather Plan 1A; 9-sec, 11.9-ft waves from 326 deg; +2.6 ft swl; river discharge 800 cfs

Photo 46. Typical wave patterns at the west entrance for Fair-Weather Plan 1B; 9-sec, 11.9-ft waves from 326 deg; +2.6 ft swl; river discharge 800 cfs

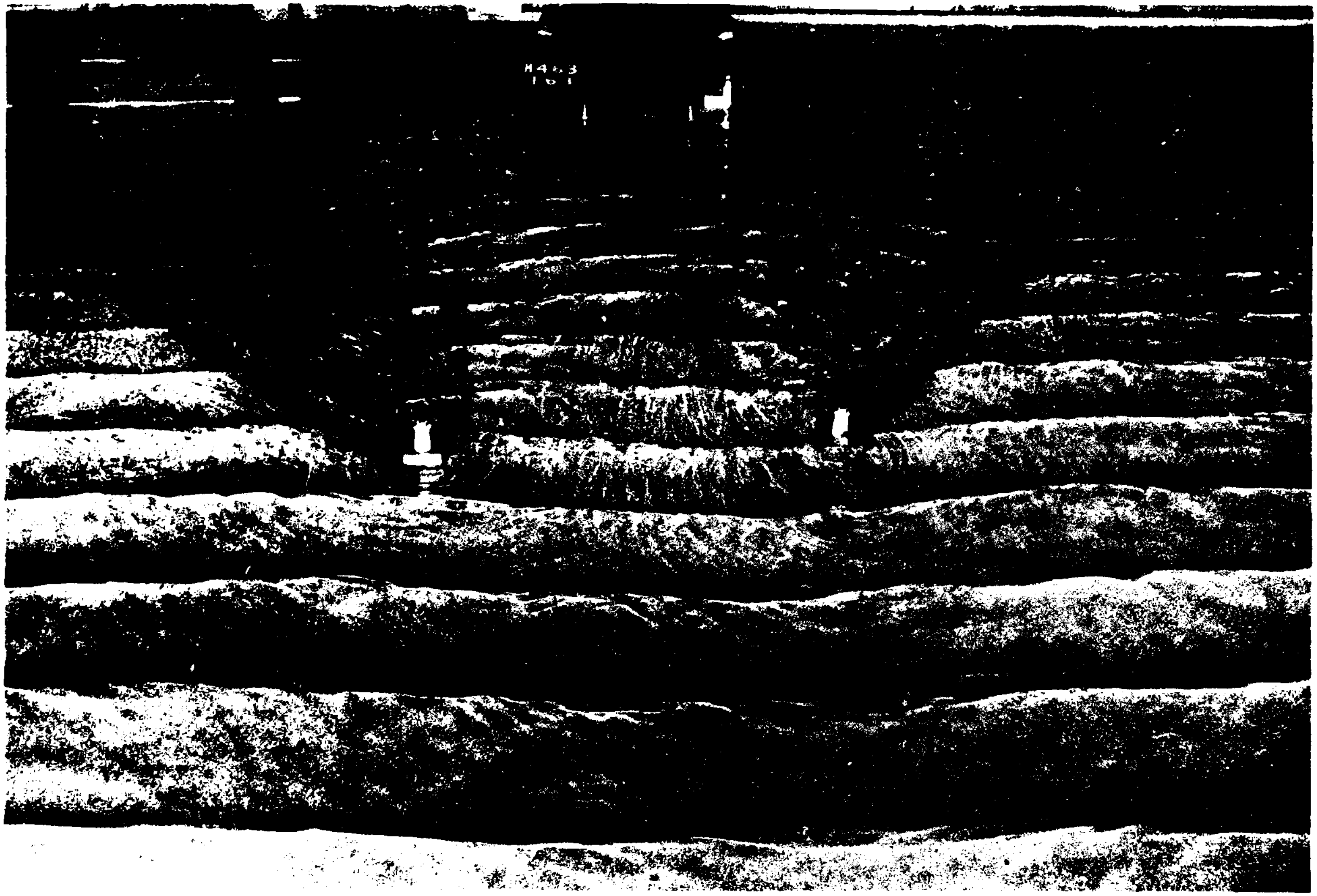


Photo 47. Typical wave patterns at the west entrance for Fair-Weather Plan 1C; 9-sec, 11.9-ft waves from 326 deg; +2.6 ft swl; river discharge 800 cfs

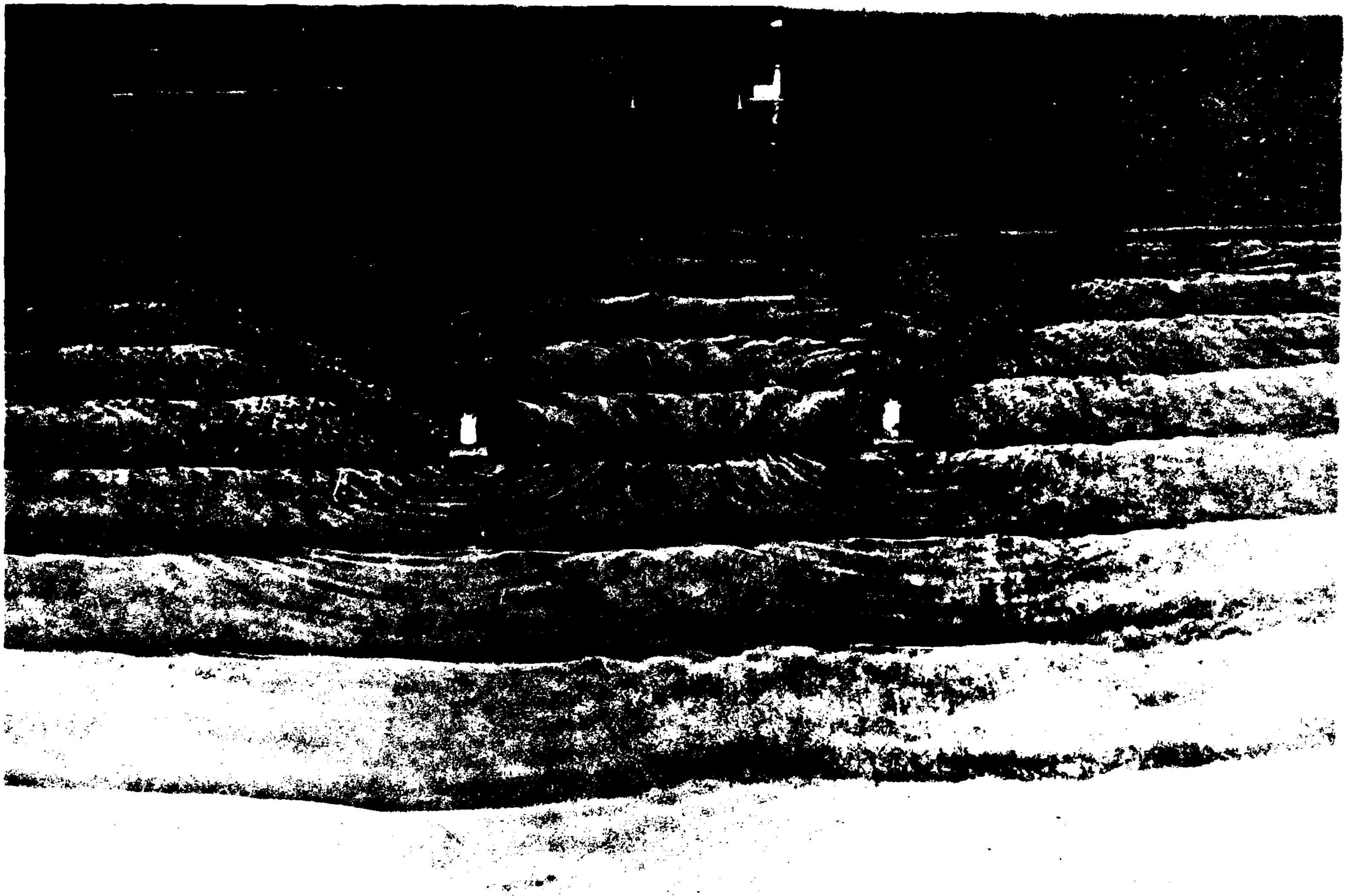


Photo 48. Typical wave patterns at the west entrance for Fair-Weather Plan 2; 9-sec, 11.9-ft waves from 326 deg; +2.6 ft swl; river discharge 800 cfs

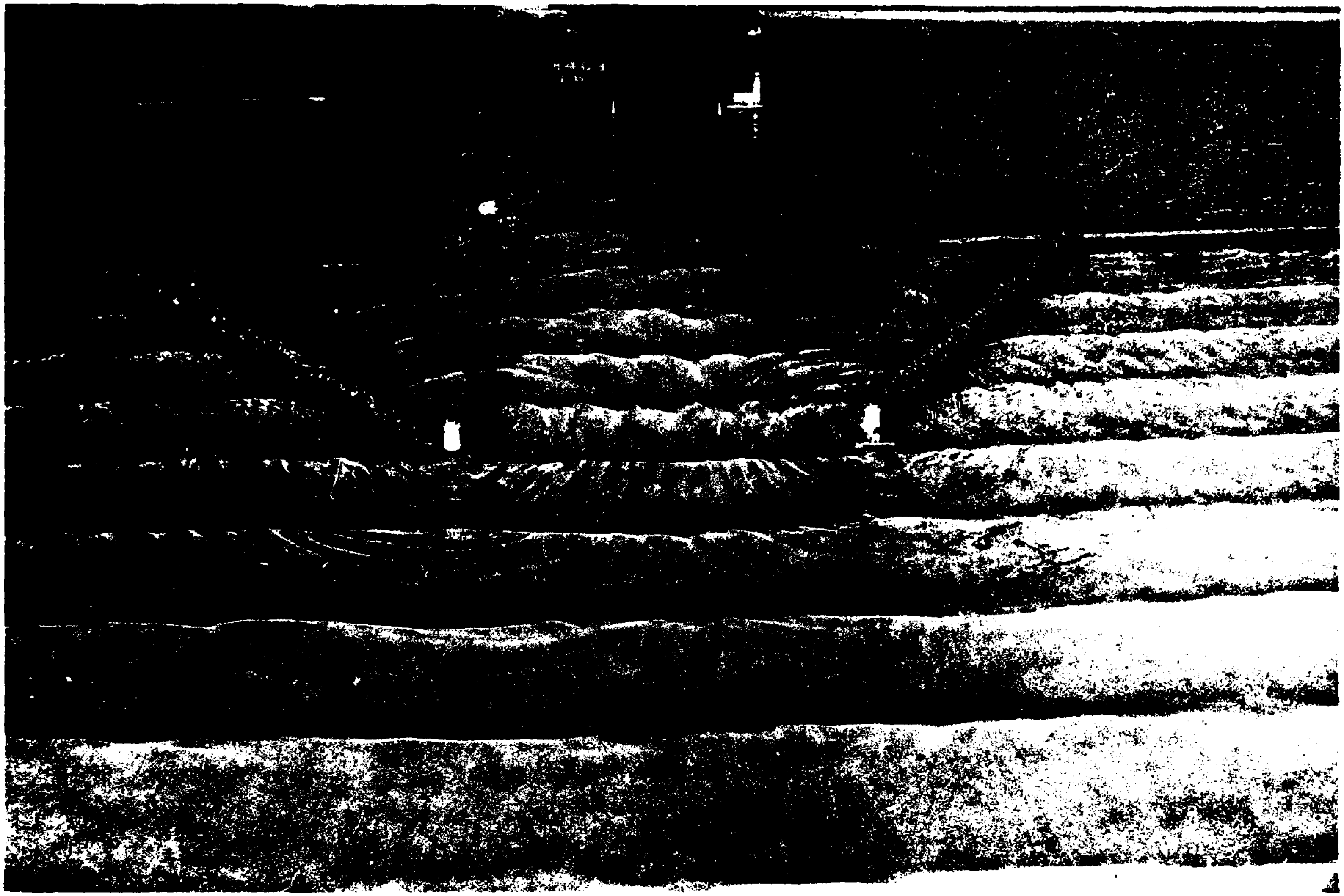


Photo 49. Typical wave patterns at the west entrance for Fair-Weather Plan 2A; 9-sec, 11.9-ft waves from 326 deg; +2.6 ft swl; river discharge 800 cfs

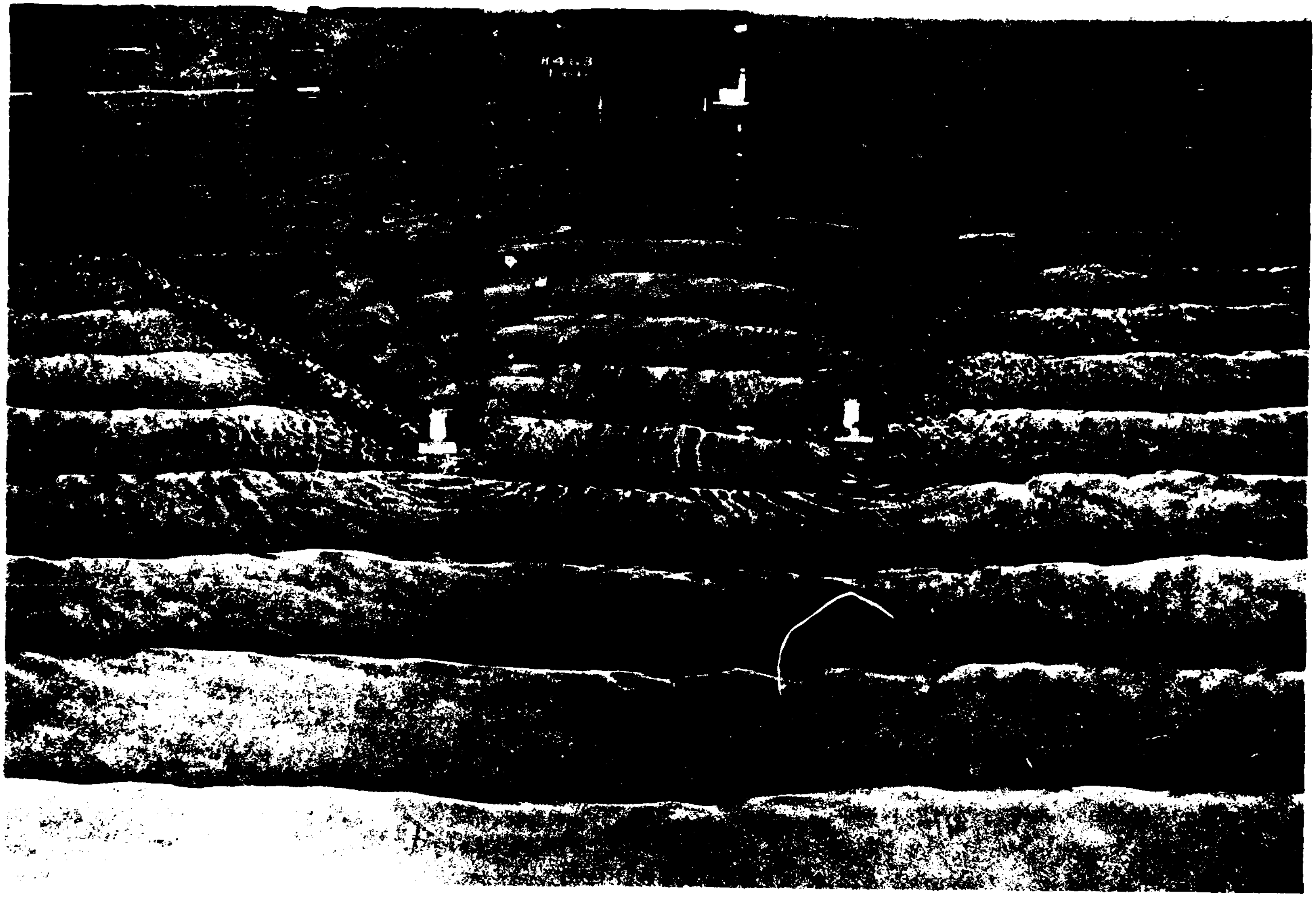


Photo 50. Typical wav- patterns at the west entrance for Fair-Weather Plan 2B; 9-sec, 11.9-ft waves from 326 deg; +2.6 ft swl; river discharge 800 cfs

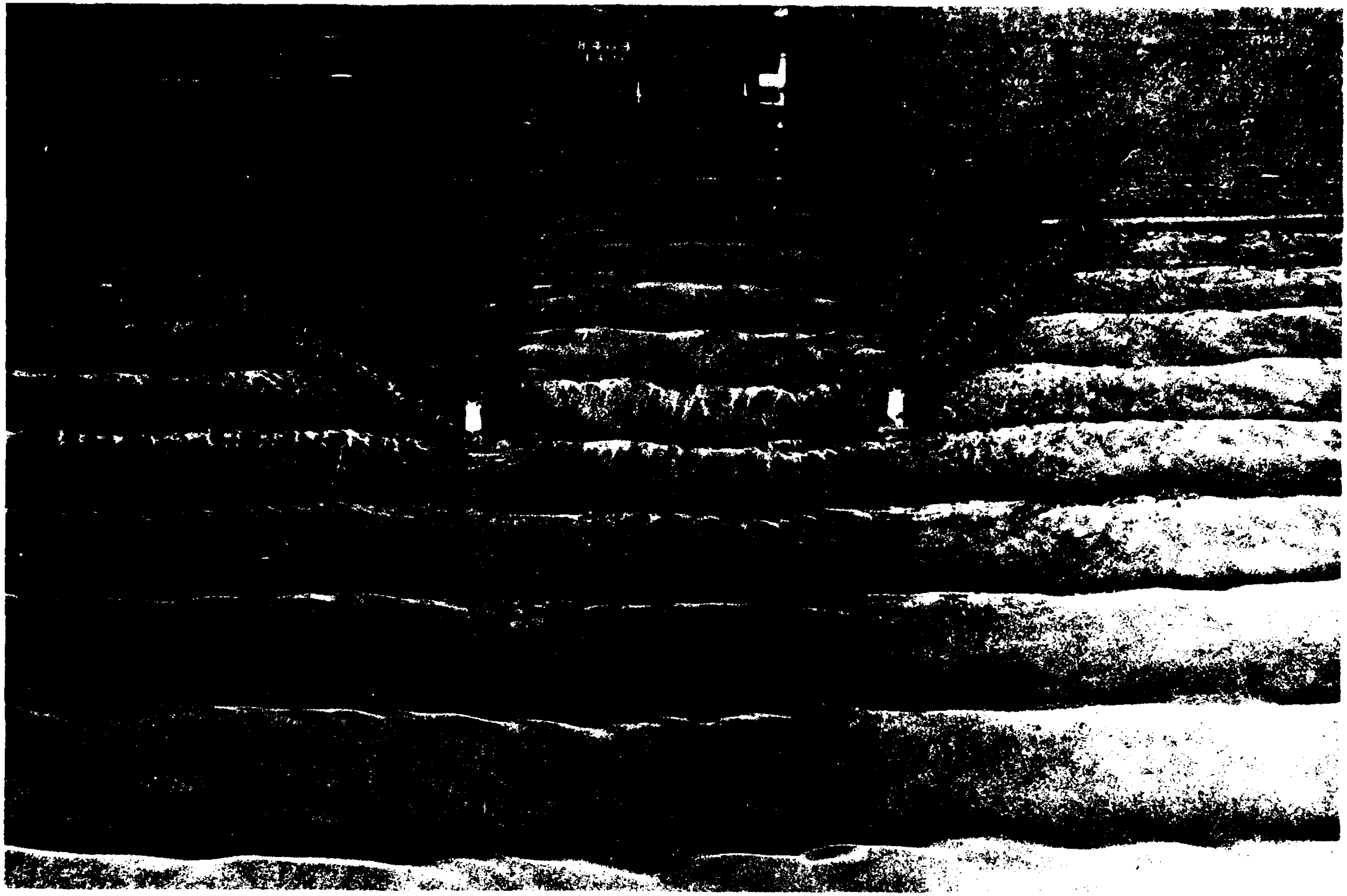


Photo 51. Typical wave patterns at the west entrance for Fair-Weather Plan 2C; 9-sec, 11.9-ft waves from 326 deg; +2.6 ft swl; river discharge 800 cfs

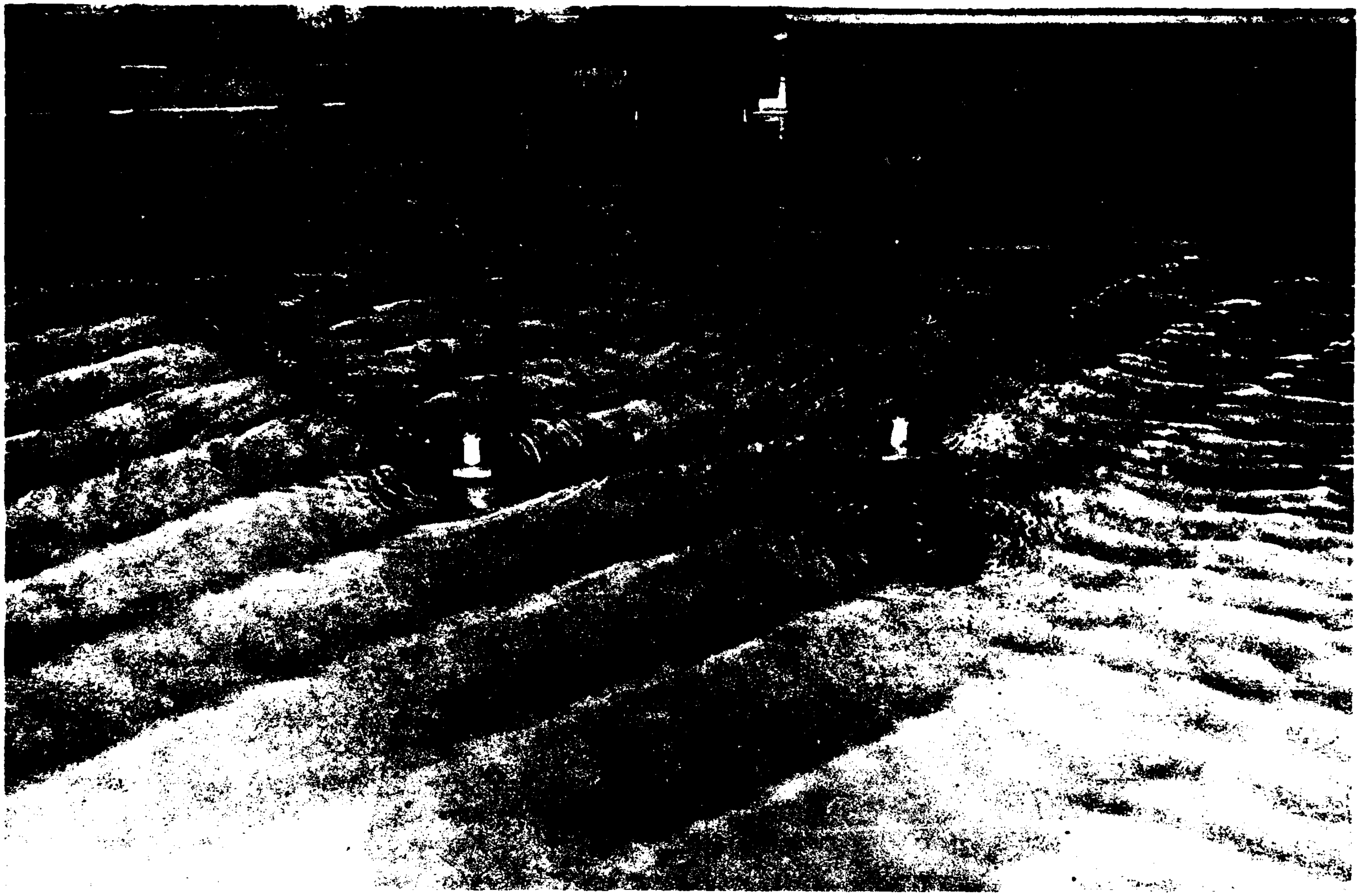


Photo 52. Typical wave patterns at the west entrance for Fair-Weather Plan 3; 9-sec, 8.6-ft waves from 279 deg; +2.6 ft swl; river discharge 800 cfs

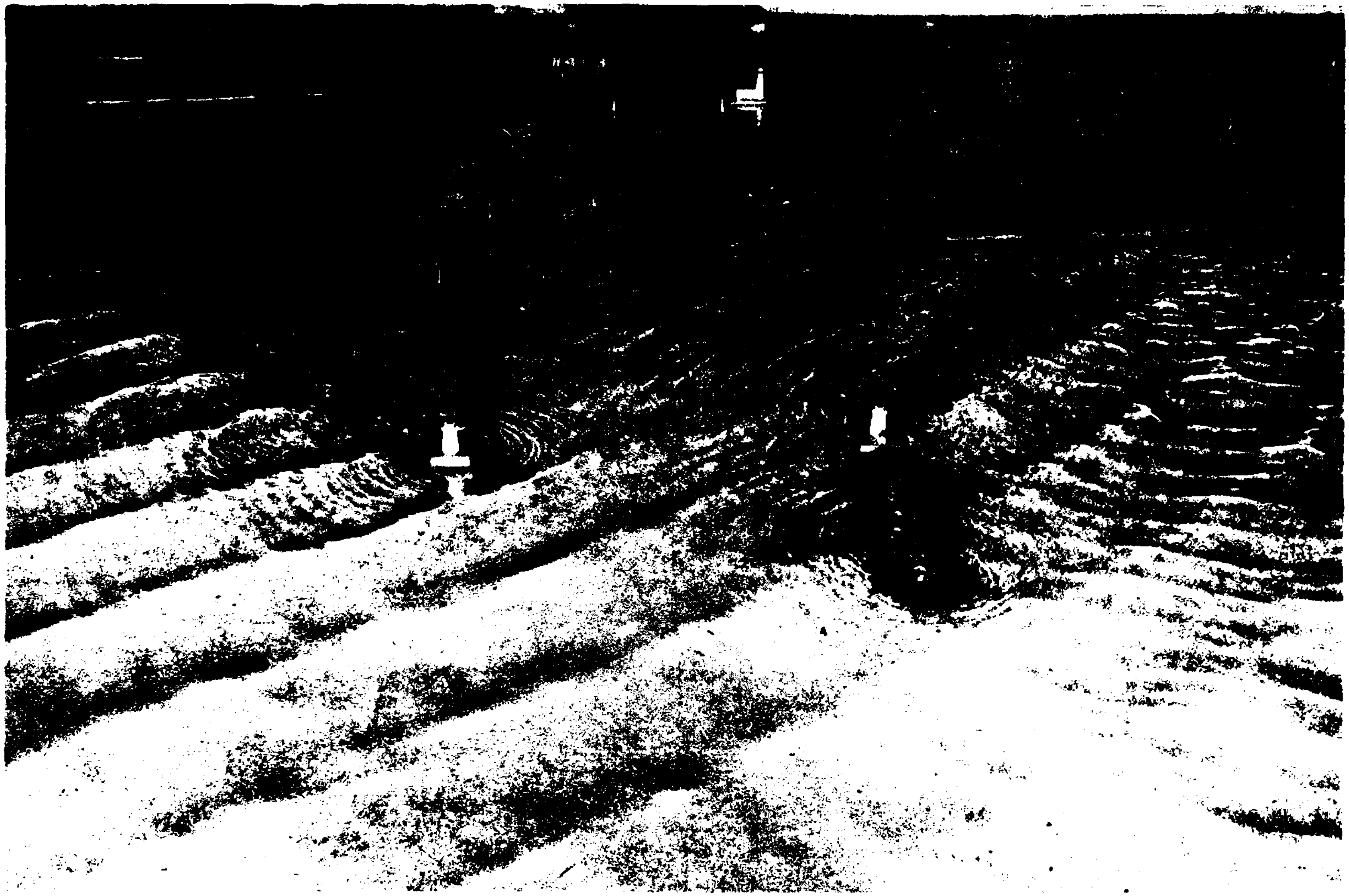


Photo 53. Typical wave patterns at the west entrance for Fair-Weather Plan 3A; 9-sec, 8.6-ft waves from 279 deg; +2.6 ft swl; river discharge 800 cfs

Photo 54. Typical wave patterns at the west entrance for Fair-Weather Plan 3B; 9-sec, 8.6-ft waves from 279 deg; +2.6 ft swl; river discharge 800 cfs

Photo 55. Typical wave patterns at the west entrance for Fair-Weather Plan 3C; 9-sec, 8.6-ft waves from 279 deg; +2.6 ft swl; river discharge 800 cfs

Photo 56. Typical wave patterns at the west entrance for Fair-Weather Plan 3D; 9-sec, 8.6-ft waves from 279 deg; +2.6 ft swl; river discharge 800 cfs


Photo 57. Typical wave patterns at the west entrance for Fair-Weather Plan 4; 9-sec, 8.6-ft waves from 279 deg; +2.6 ft swl; river discharge 800 cfs


Photo 58. Typical wave patterns at the west entrance for Fair-Weather Plan 4A; 9-sec, 8.6-ft waves from 279 deg; +2.6 ft swl; river discharge 800 cfs


Photo 59. Typical wave patterns at the west entrance for Fair-Weather Plan 4B; 9-sec, 8.6-ft waves from 279 deg; +2.6 ft swl; river discharge 800 cfs

Photo 60. Typical wave patterns at the west entrance for Fair-Weather Plan 4C; 9-sec, 8.6-ft waves from 279 deg; +2.6 ft swl; river discharge 800 cfs

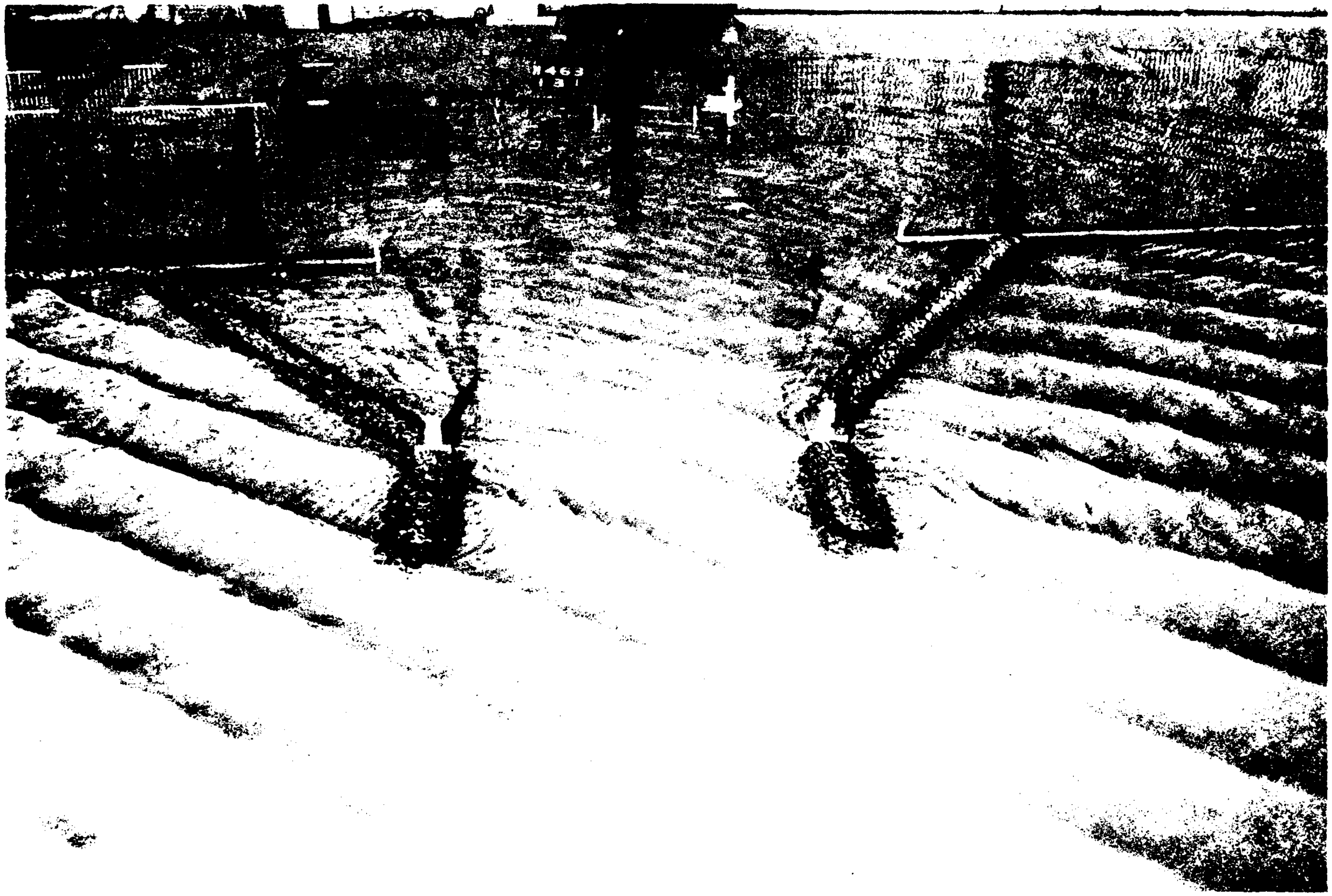


Photo 61. Typical wave patterns at the west entrance for Fair-Weather Plan 4D; 8-sec, 9.8-ft waves from 17 deg; +2.6 ft swl; river discharge 800 cfs

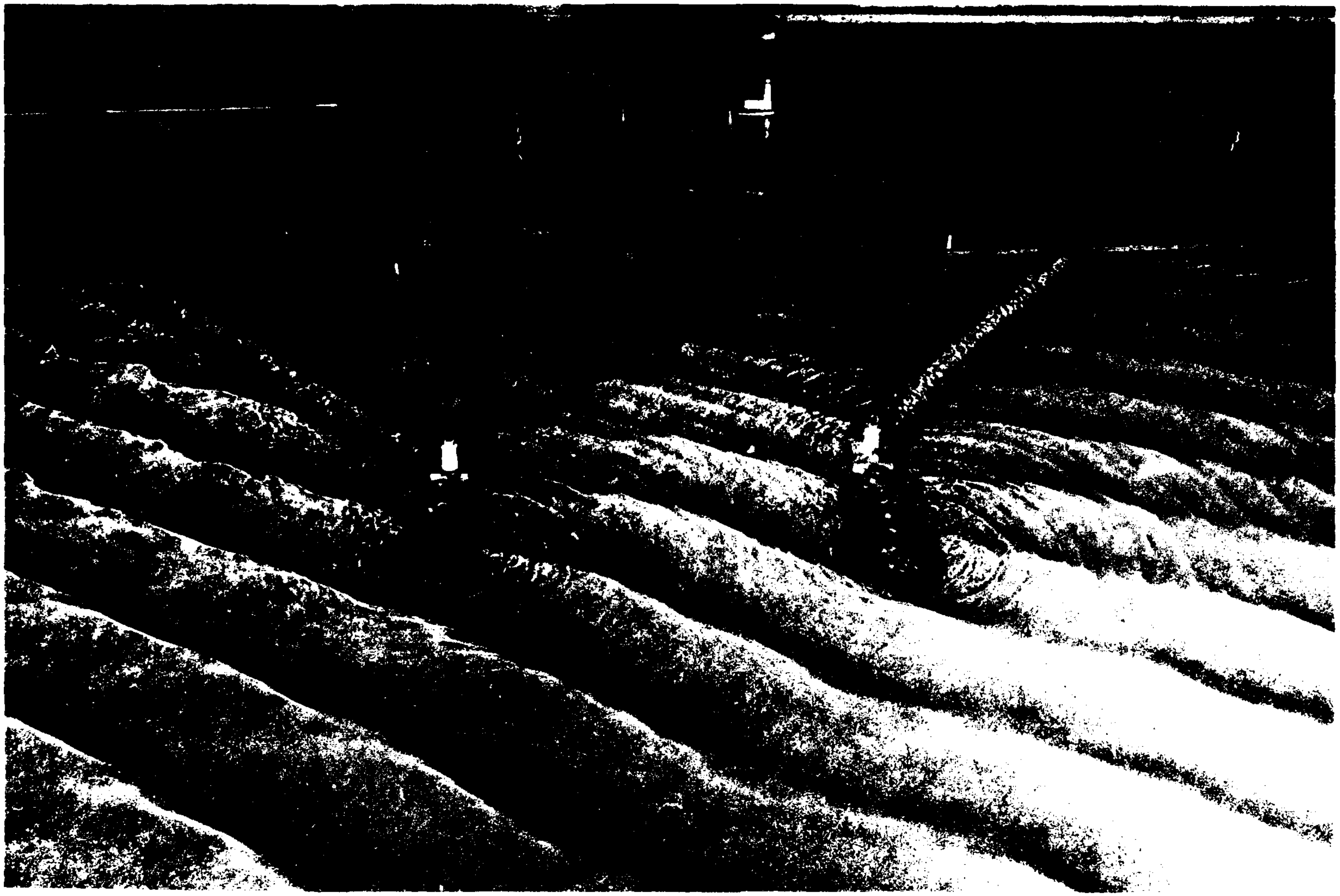


Photo 62. Typical wave patterns at the west entrance for Fair-Weather Plan 4E; 8-sec, 9.8-ft waves from 17 deg; +2.6 ft swl; river discharge 800 cfs

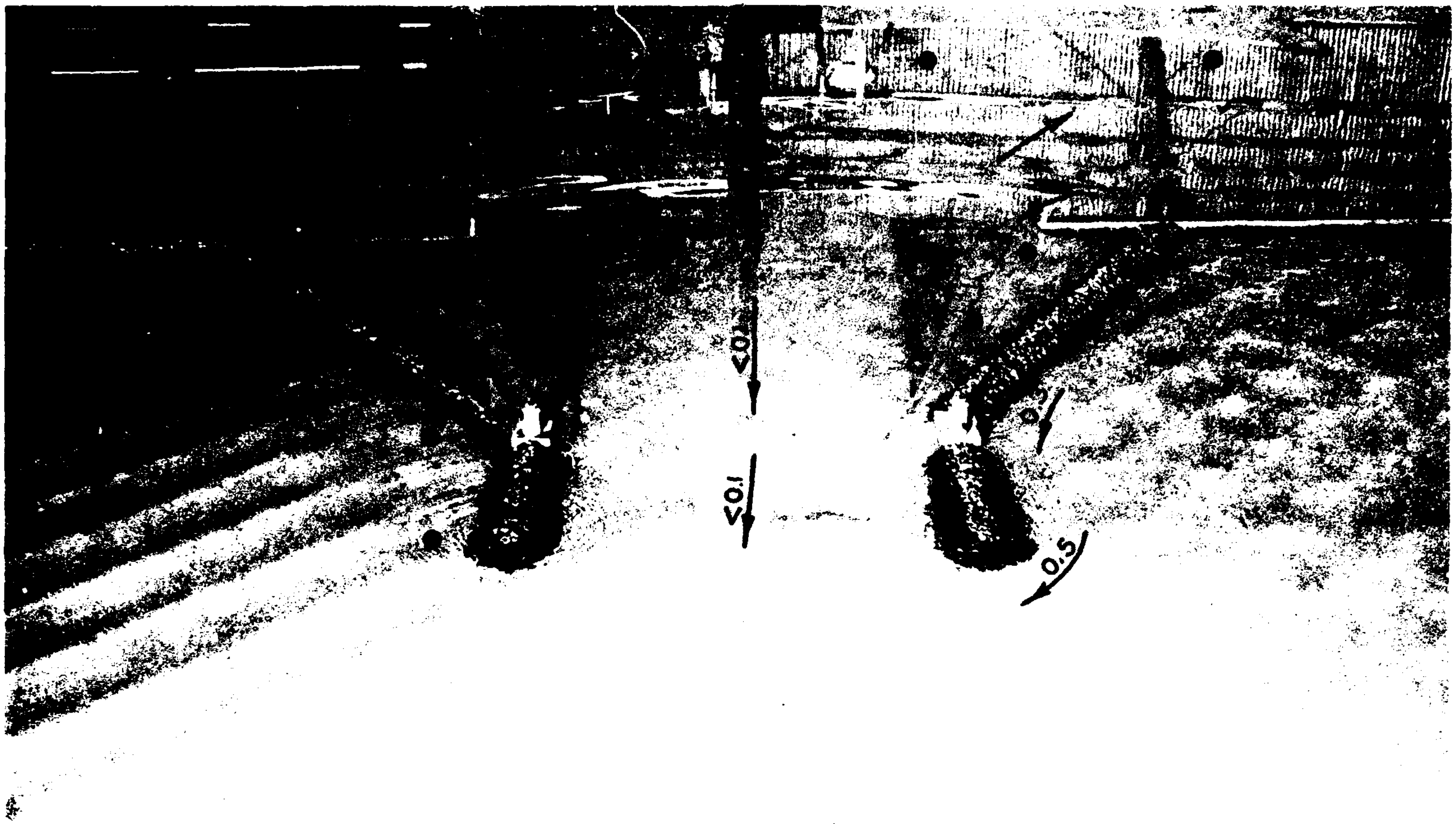
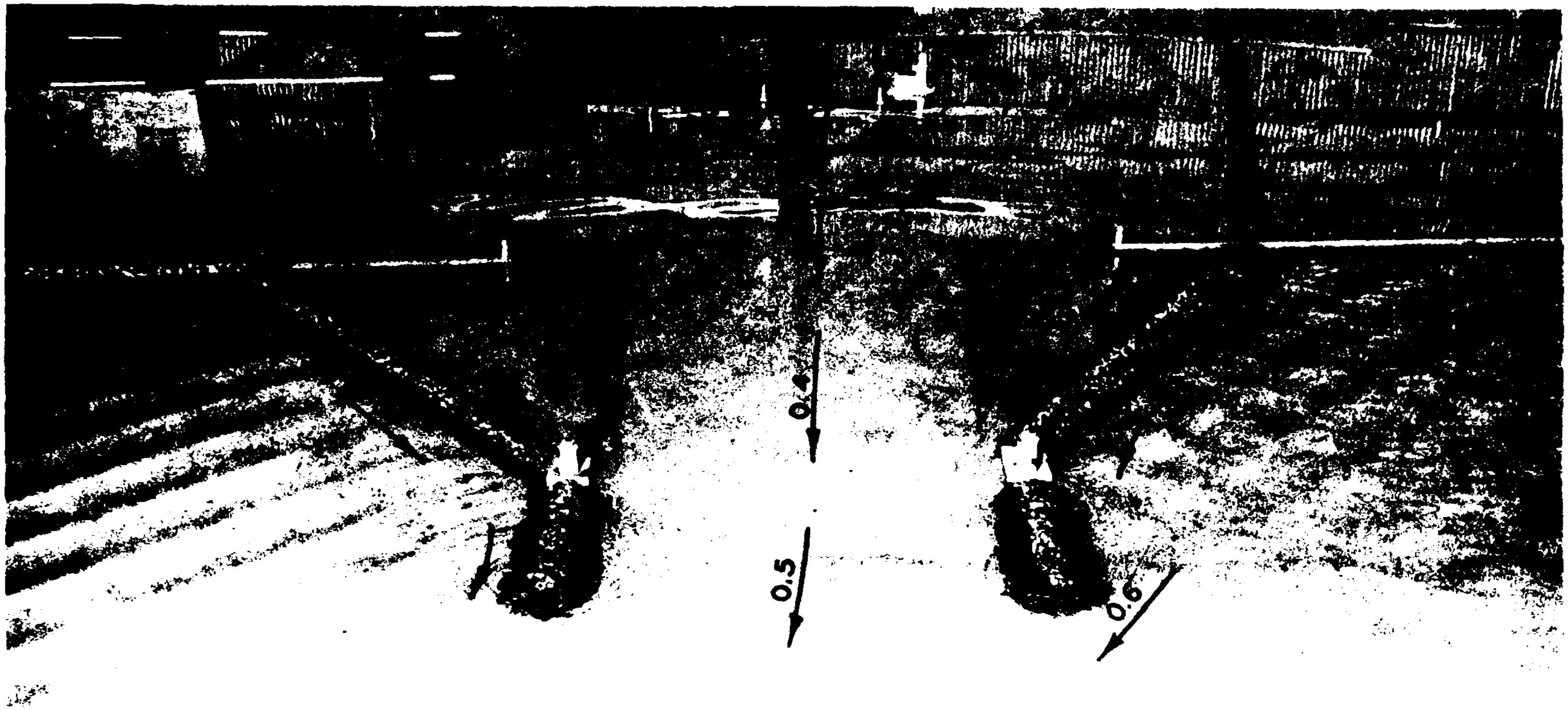
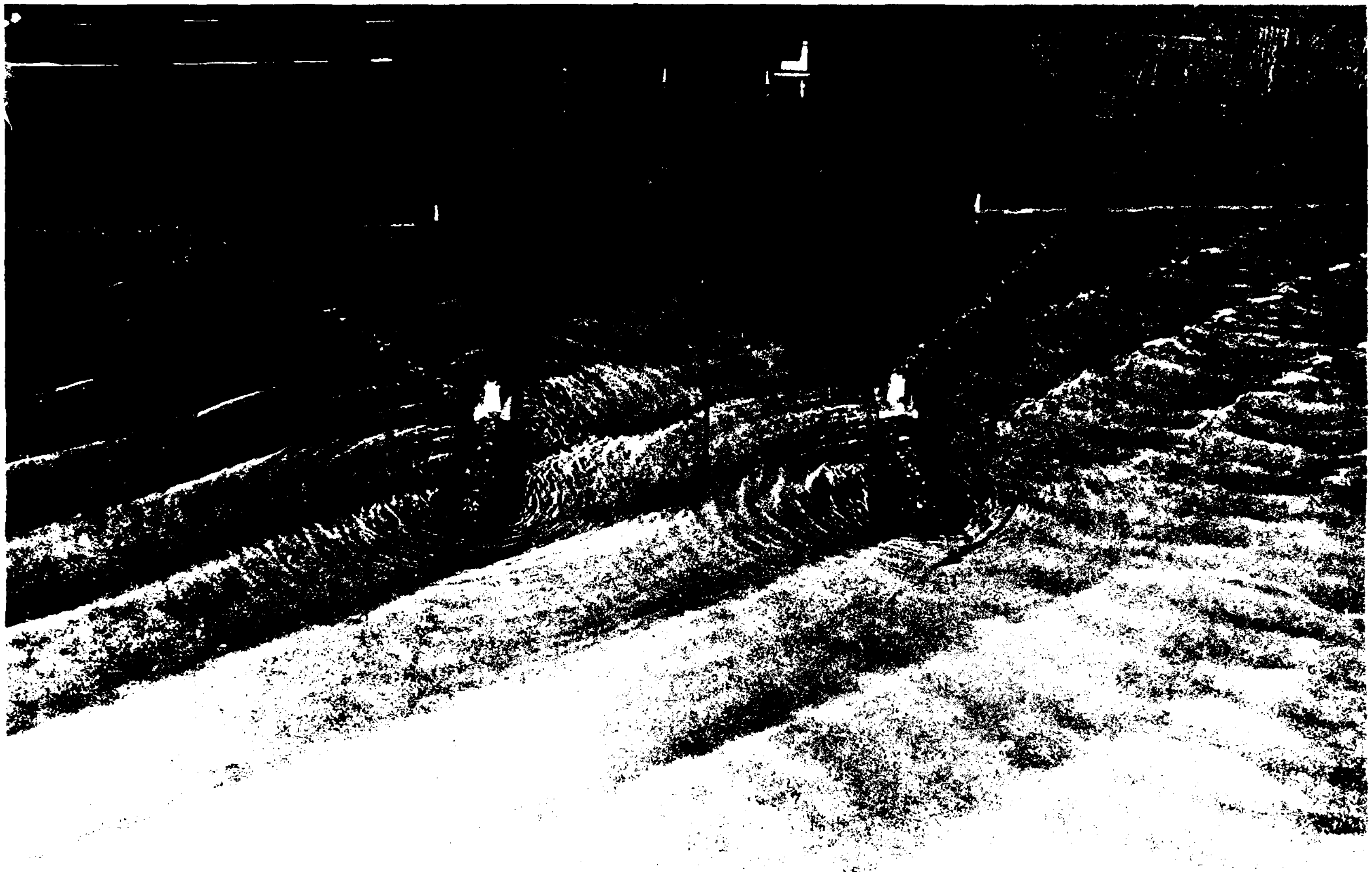



Photo 63. Typical wave patterns, current patterns, and current magnitudes (prototype feet per second) at the west entrance for Fair-Weather Plan 4D; 6-sec, 3.9-ft waves from 279 deg; 0.0-ft swl; river discharge 800 cfs




● INDICATES NO CURRENT MOVEMENT

Photo 64. Typical wave patterns, current patterns, and current magnitudes (prototype feet per second) at the west entrance for Fair-Weather Plan 4D; 6-sec, 3.9-ft waves from 279 deg; 0.0-ft swl; river discharge 8,000 cfs



● INDICATES NO CURRENT MOVEMENT

Photo 65. Typical wave patterns, current patterns, and current magnitudes (prototype feet per second) at the west entrance for Fair-Weather Plan 4D; 9-sec, 8.6-ft waves from 279 deg; 0.0-ft swl; river discharge 800 cfs

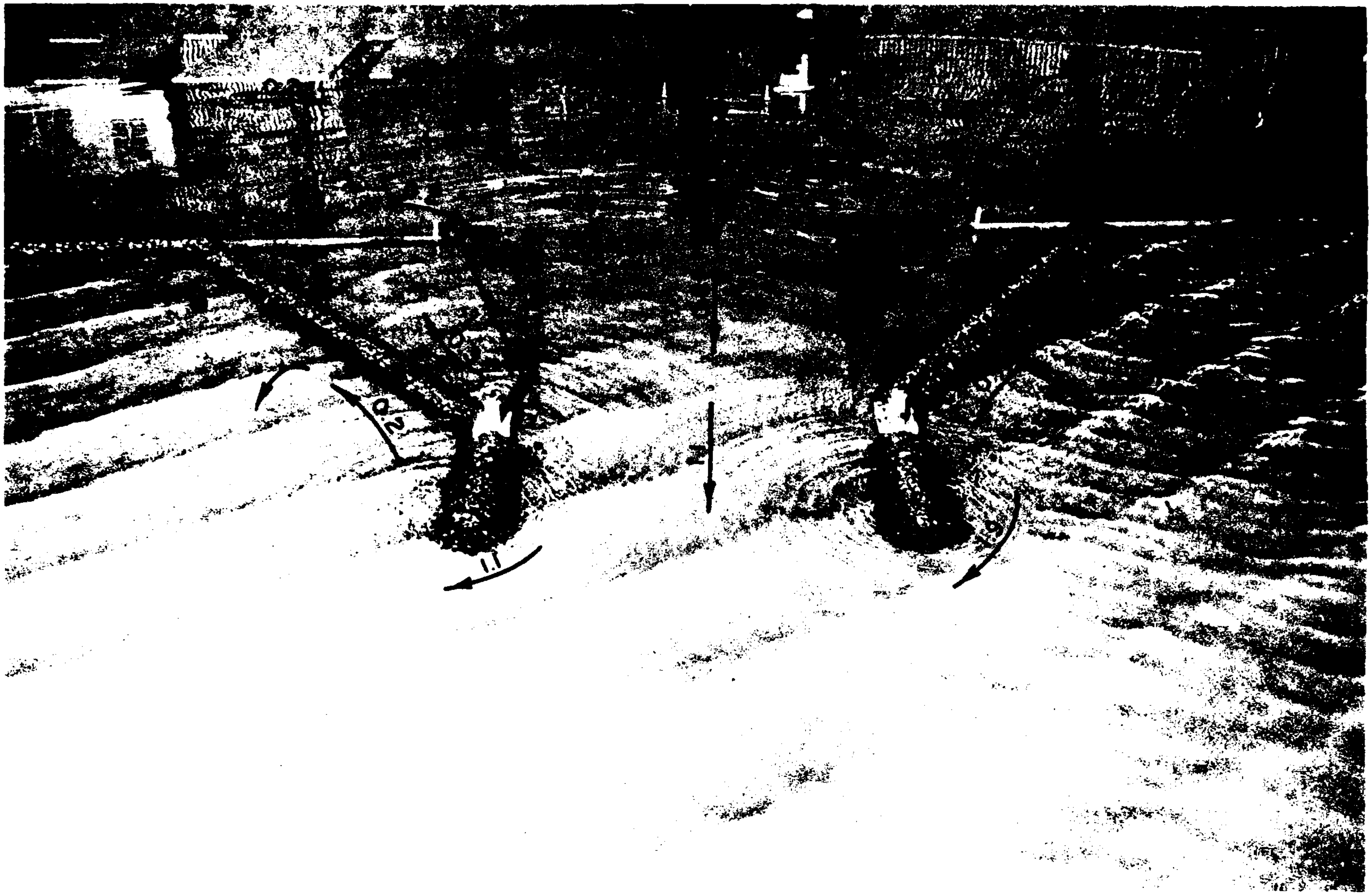


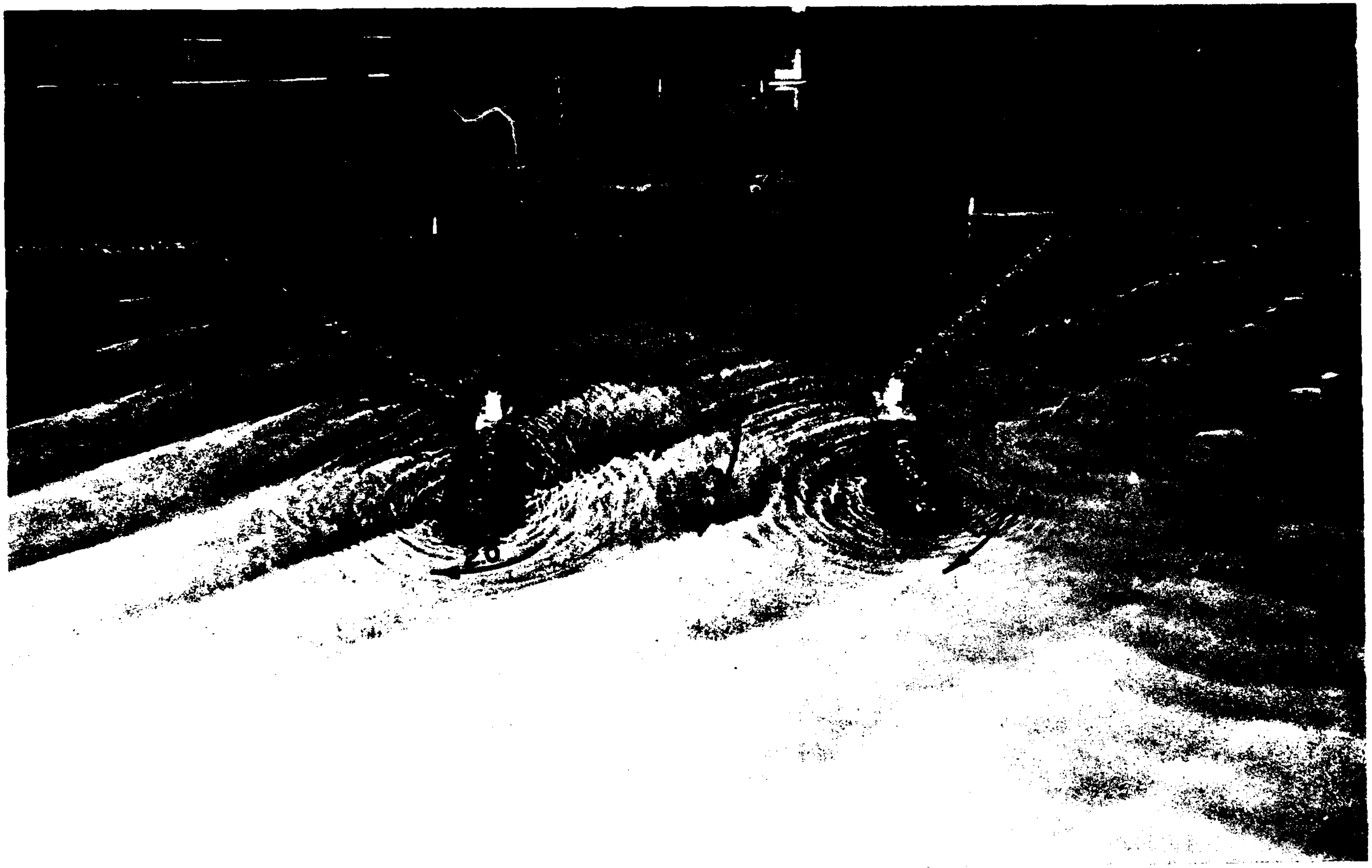

Photo 66. Typical wave patterns, current patterns, and current magnitudes (prototype feet per second) at the west entrance for Fair-Weather Plan 4D; 9-sec, 8.6-ft waves from 279 deg; 0.0-ft swl; river discharge 8,000 cfs

● INDICATES NO CURRENT MOVEMENT

Photo 67. Typical wave patterns, current patterns, and current magnitudes (prototype feet per second) at the west entrance for Fair-Weather Plan 4D; 6-sec, 3.9-ft waves from 279 deg; +2.6 ft swl; river discharge 800 cfs

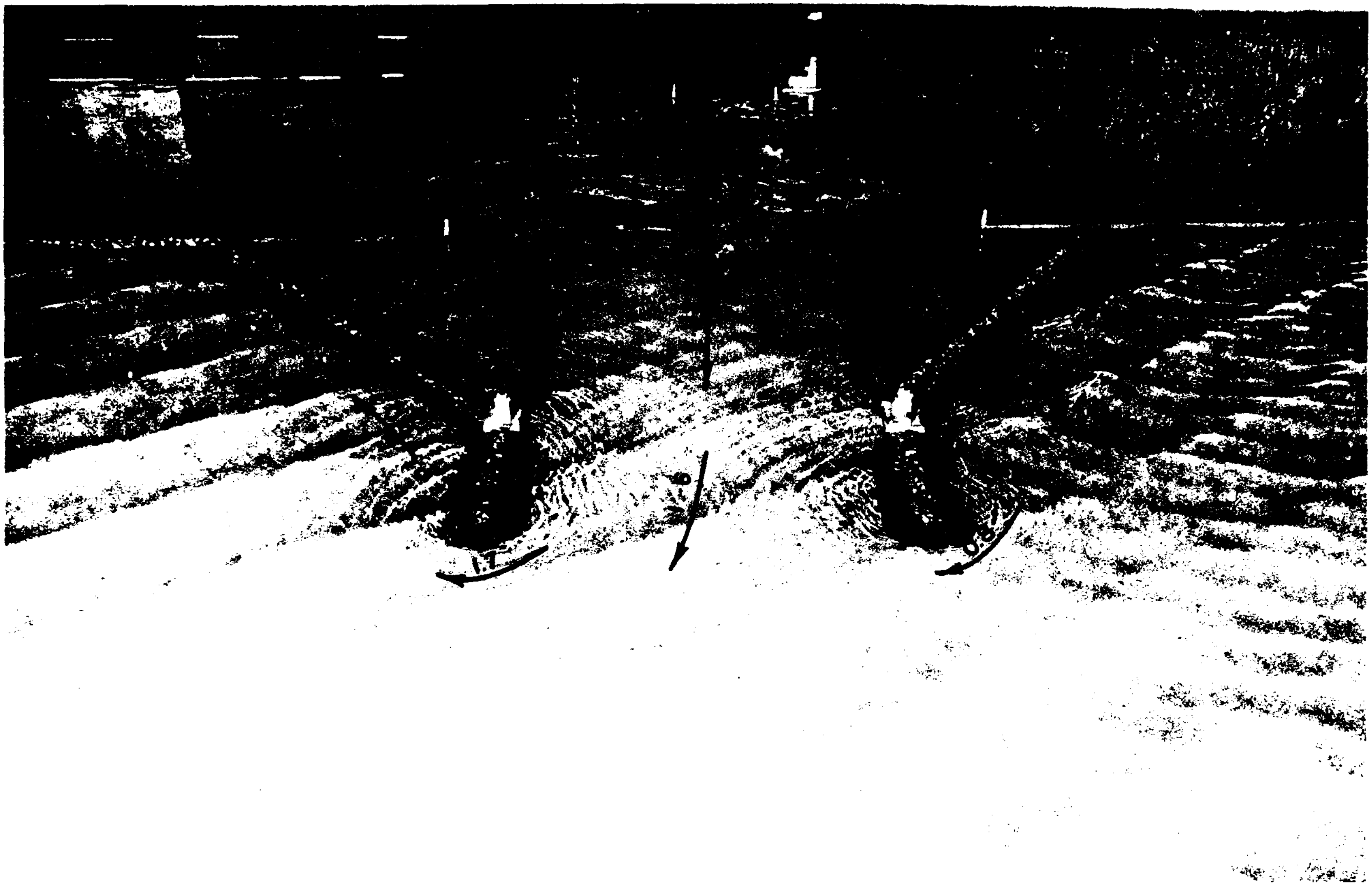

● INDICATES NO CURRENT MOVEMENT

Photo 68. Typical wave patterns, current patterns, and current magnitudes (prototype feet per second) at the west entrance for Fair-Weather Plan 4D; 6-sec, 3.9-ft waves from 279 deg; +2.6 ft swl; river discharge 8,000 cfs




● INDICATES NO CURRENT MOVEMENT

Photo 69. Typical wave patterns, current patterns, and current magnitudes (prototype feet per second) at the west entrance for Fair-Weather Plan 4D; 9-sec, 8.6-ft waves from 279 deg; +2.6 ft swl; river discharge 800 cfs



● INDICATES NO CURRENT MOVEMENT

Photo 70. Typical wave patterns, current patterns, and current magnitudes (prototype feet per second) at the west entrance for Fair-Weather Plan 4D; 9-sec, 8.6-ft waves from 279 deg; +2.6 ft swl; river discharge 8,000 cfs


●INDICATES NO CURRENT MOVEMENT

Photo 71. Typical wave patterns, current patterns, and current magnitudes (prototype feet per second) at the west entrance for Fair-Weather Plan 4D; 6-sec, 3.9-ft waves from 279 deg; +4.8 ft swl; river discharge 800 cfs

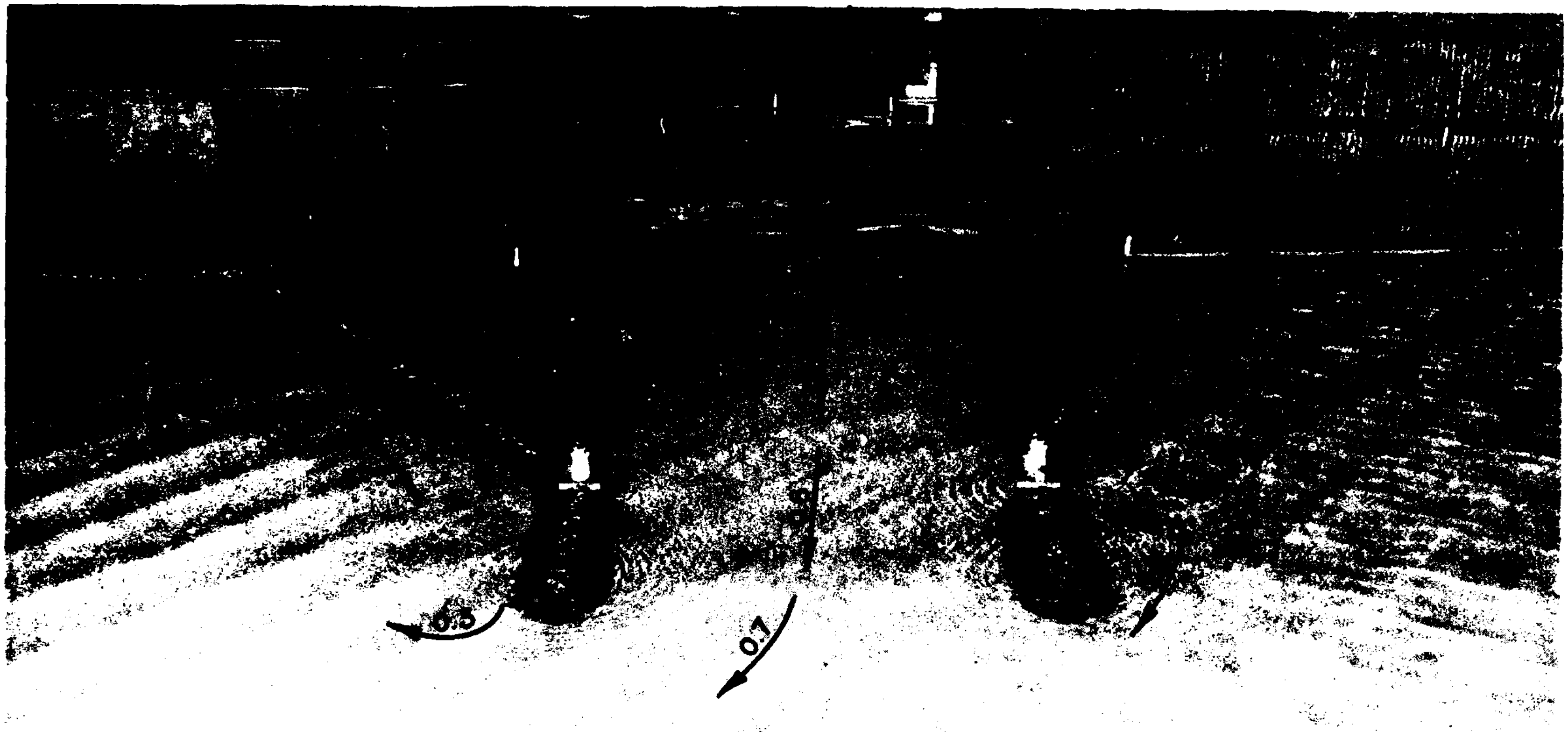



Photo 72. Typical wave patterns, current patterns, and current magnitudes (prototype feet per second) at the west entrance for Fair-Weather Plan 4D; 6-sec, 3.9-ft waves from 279 deg; +4.8 ft swl; river discharge 8,000 cfs

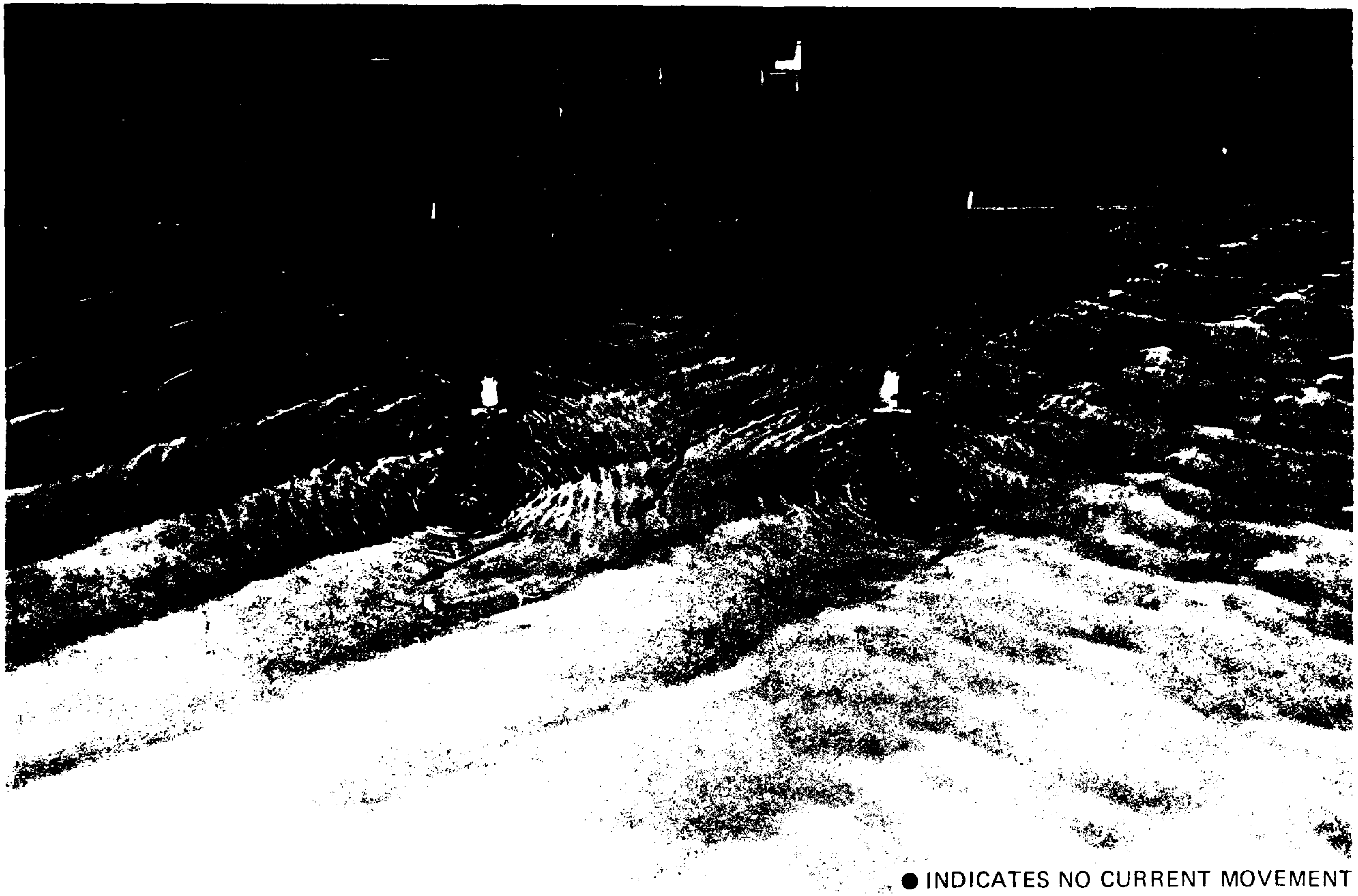



Photo 73. Typical wave patterns, current patterns, and current magnitudes (prototype feet per second) at the west entrance for Fair-Weather Plan 4D; 9-sec, 8.6-ft waves from 279 deg; +4.8 ft swl; river discharge 800 cfs


Photo 74. Typical wave patterns, current patterns, and current magnitudes (prototype feet per second) at the west entrance for Fair-Weather Plan 4D; 9-sec, 8.6-ft waves from 279 deg; +4.8 ft swl; river discharge 8,000 cfs

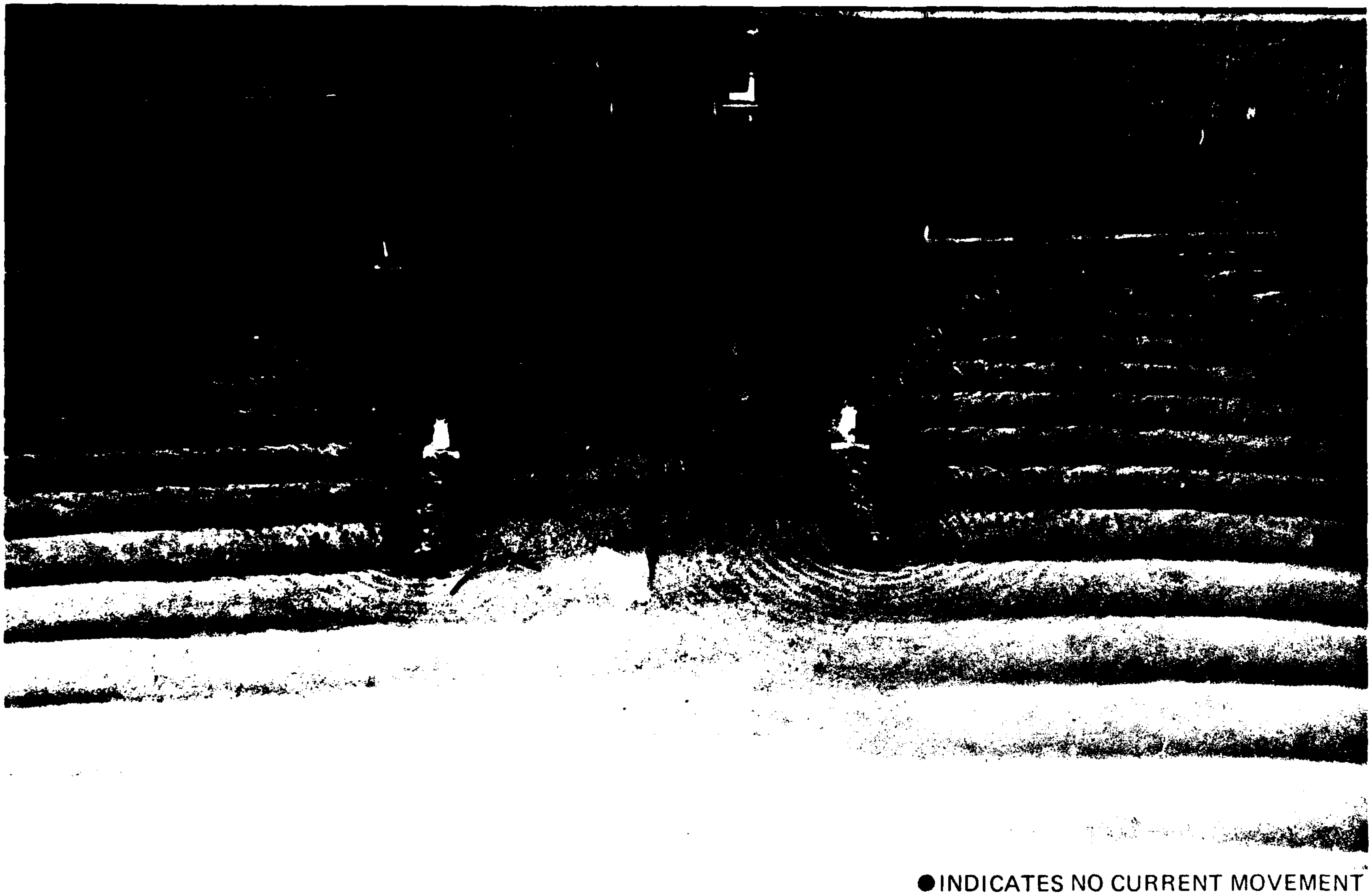
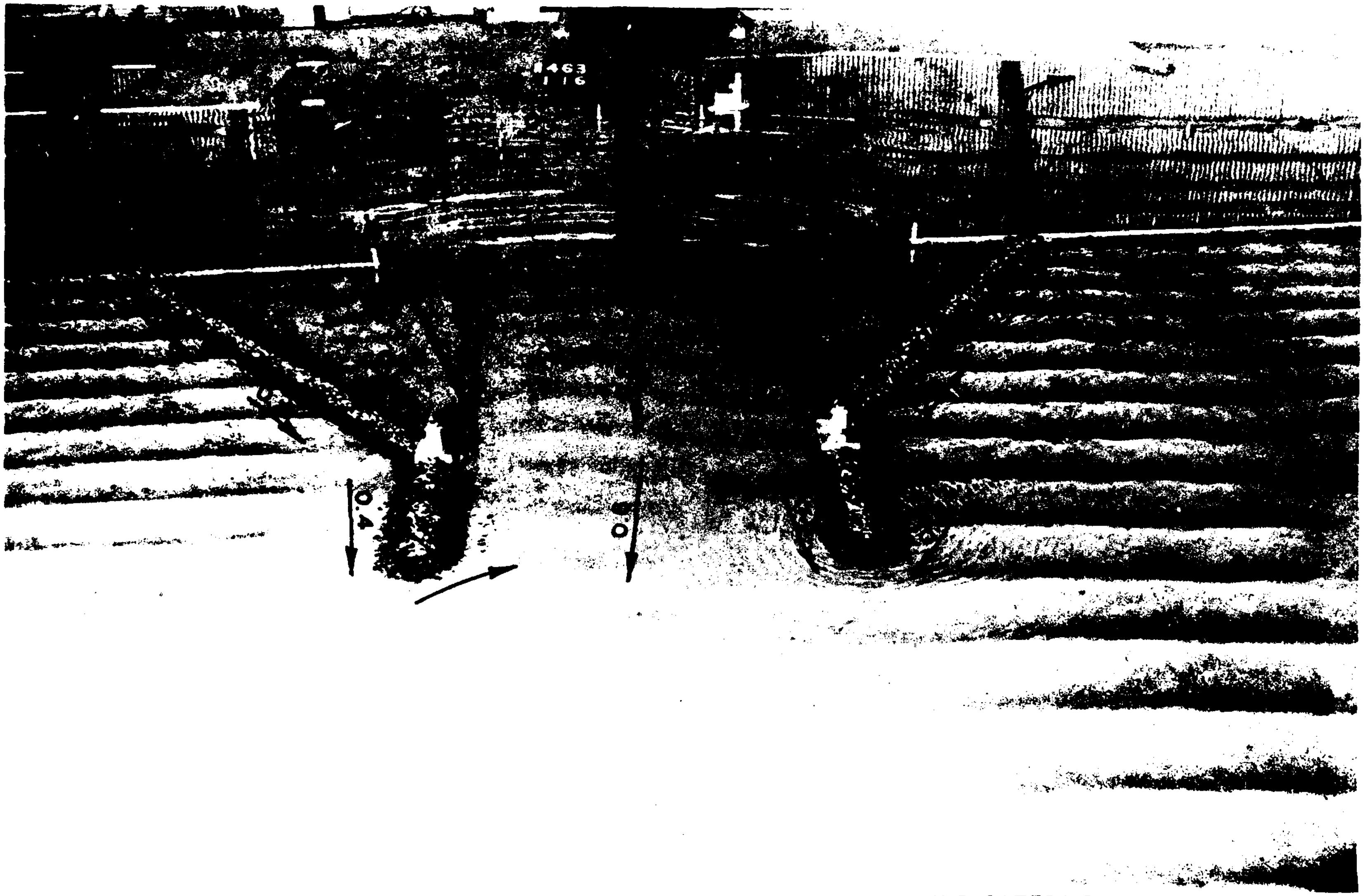


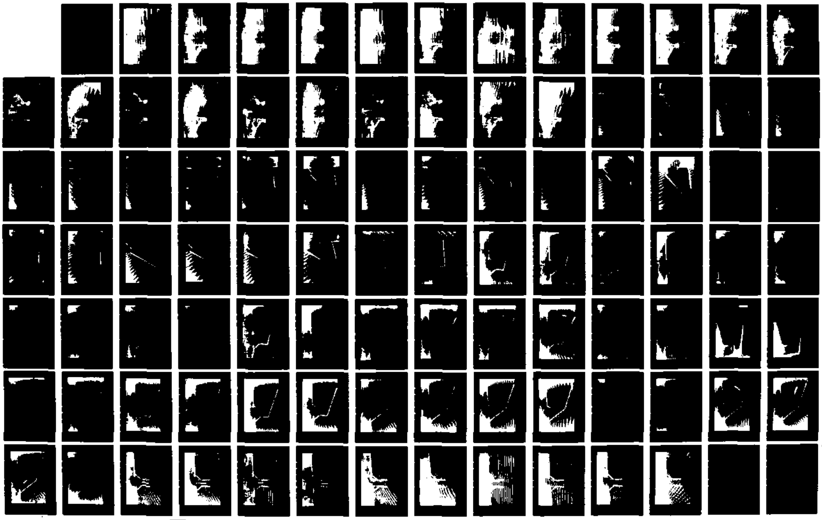

Photo 75. Typical wave patterns, current patterns, and current magnitudes (prototype feet per second) at the west entrance for Fair-Weather Plan 4D; 6-sec, 5.6-ft waves from 326 deg; 0.0-ft swl; river discharge 800 cfs

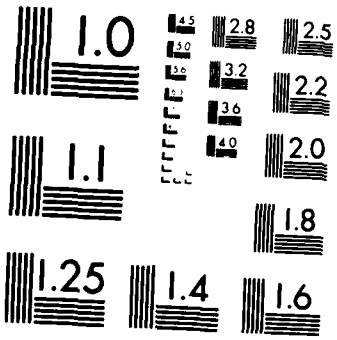



●INDICATES NO CURRENT MOVEMENT

Photo 76. Typical wave patterns, current patterns, and current magnitudes (prototype feet per second) at the west entrance for Fair-Weather Plan 4D; 6-sec, 5.6-ft waves from 326 deg; 0.0-ft swl; river discharge 8,000 cfs

AD-A129 783 CLEVELAND HARBOR OHIO DESIGN FOR THE SAFE AND EFFICIENT 3/4
PASSAGE OF 1000-F..(U) ARMY ENGINEER WATERWAYS
EXPERIMENT STATION VICKSBURG MS HYDRA.. R R BOTTIN
UNCLASSIFIED MAR 83 WES/TR/HL-83-6 F/G 13/2 NL



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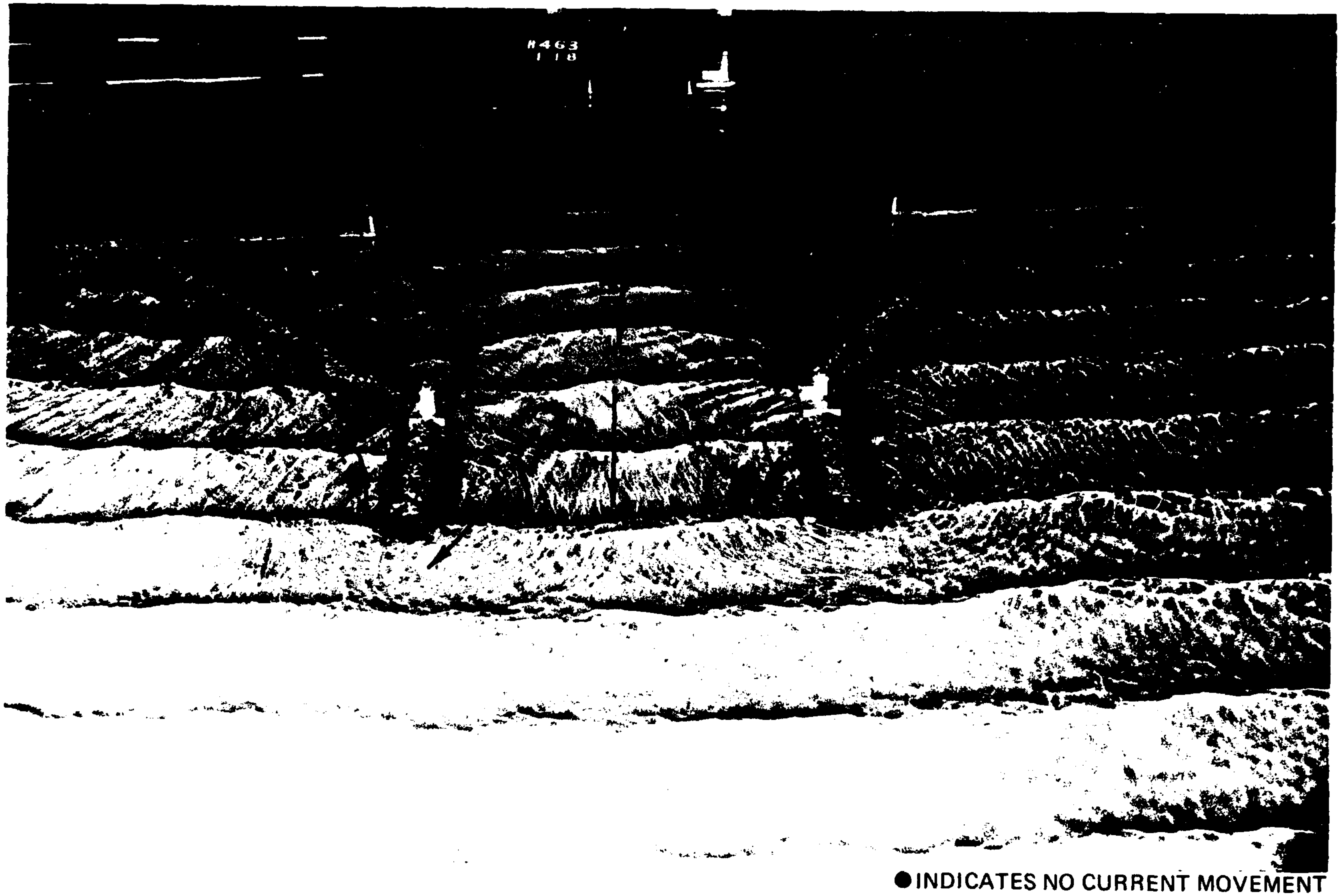



Photo 77. Typical wave patterns, current patterns, and current magnitudes (prototype feet per second) at the west entrance for Fair-Weather Plan 4D; 9-sec, 11.9-ft waves from 326 deg; 0.0-ft swl; river discharge 800 cfs


●INDICATES NO CURRENT MOVEMENT

Photo 78. Typical wave patterns, current patterns, and current magnitudes (prototype feet per second) at the west entrance for Fair-Weather Plan 4D; 9-sec, 11.9-ft waves from 326 deg; 0.0-ft swl; river discharge 8,000 cfs


●INDICATES NO CURRENT MOVEMENT

Photo 79. Typical wave patterns, current patterns, and current magnitudes (prototype feet per second) at the west entrance for Fair-Weather Plan 4D; 6-sec, 5.6-ft waves from 326 deg; +2.6 ft swl; river discharge 800 cfs


Photo 80. Typical wave patterns, current patterns, and current magnitudes (prototype feet per second) at the west entrance for Fair-Weather Plan 4D; 6-sec, 5.6-ft waves from 326 deg; +2.6 ft swl; river discharge 8,000 cfs

● INDICATES NO CURRENT MOVEMENT

Photo 81. Typical wave patterns, current patterns, and current magnitudes (prototype feet per second) at the west entrance for Fair-Weather Plan 4D; 9-sec, 11.9-ft waves from 326 deg; +2.6 ft swl; river discharge 800 cfs


Photo 82. Typical wave patterns, current patterns, and current magnitudes (prototype feet per second) at the west entrance for Fair-Weather Plan 4D; 9-sec, 11.9-ft waves from 326 deg; +2.6 ft swl; river discharge 8,000 cfs


Photo 83. Typical wave patterns, current patterns, and current magnitudes (prototype feet per second) at the west entrance for Fair-Weather Plan 4D; 9-sec, 11.9-ft waves from 326 deg; +4.8 ft swl; river discharge 800 cfs

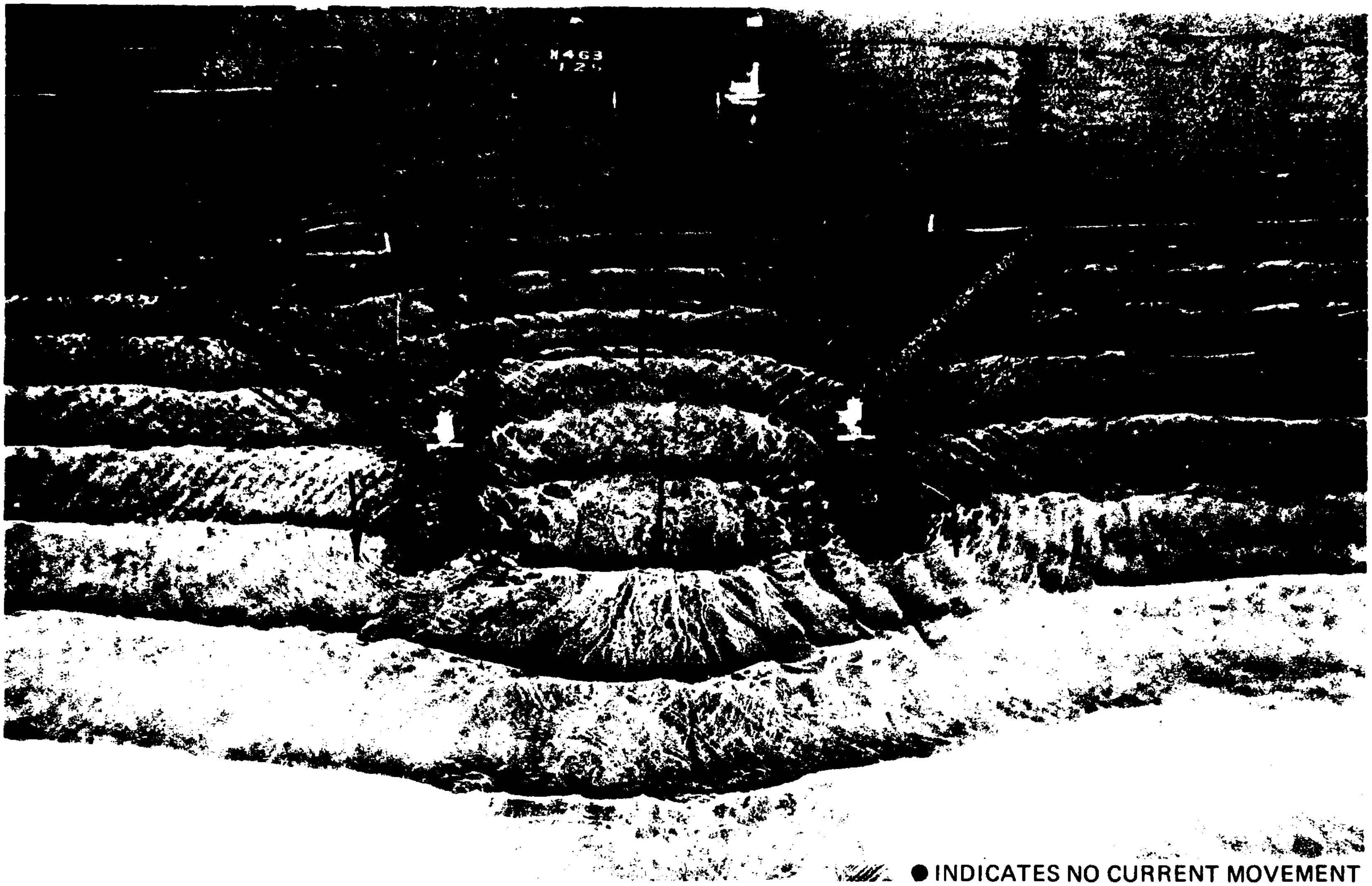



Photo 84. Typical wave patterns, current patterns, and current magnitudes (prototype feet per second) at the west entrance for Fair-Weather Plan 4D; 9-sec, 11.9-ft waves from 326 deg; +4.8 ft swl; river discharge 8,000 cfs

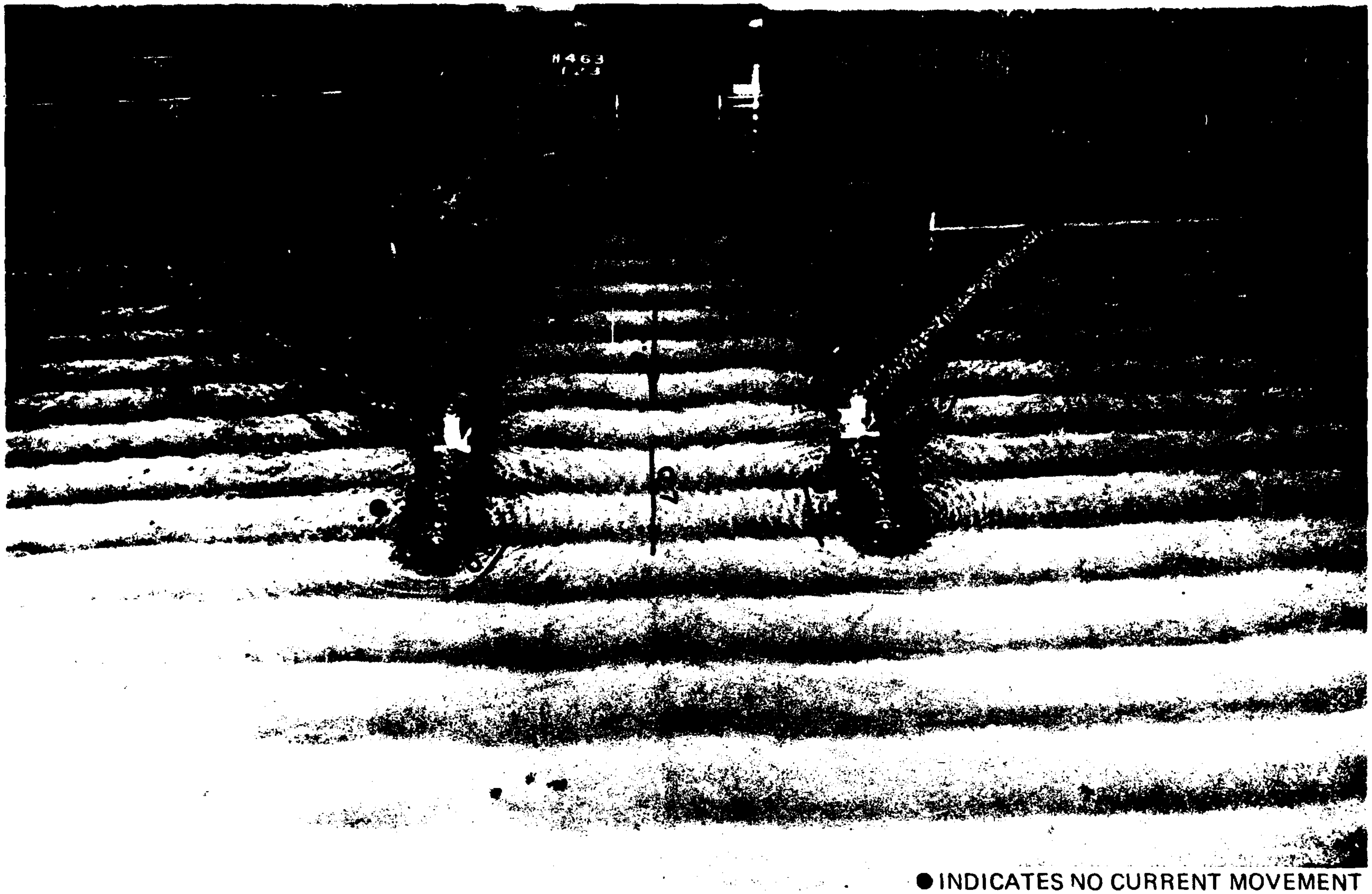



Photo 85. Typical wave patterns, current patterns, and current magnitudes (prototype feet per second) at the west entrance for Fair-Weather Plan 4D; 6-sec, 5.6-ft waves from 326 deg; +4.8 ft swl; river discharge 800 cfs

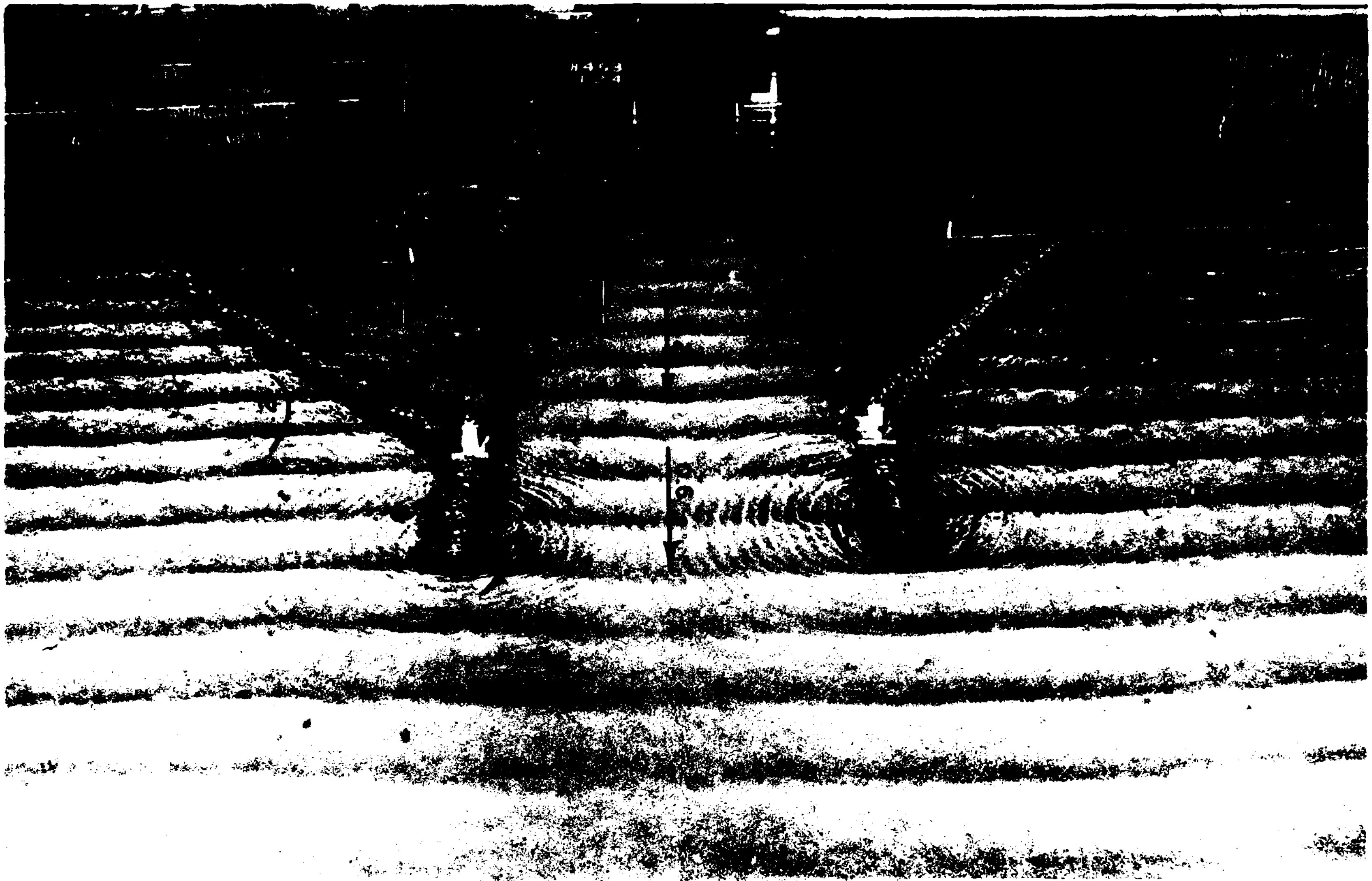
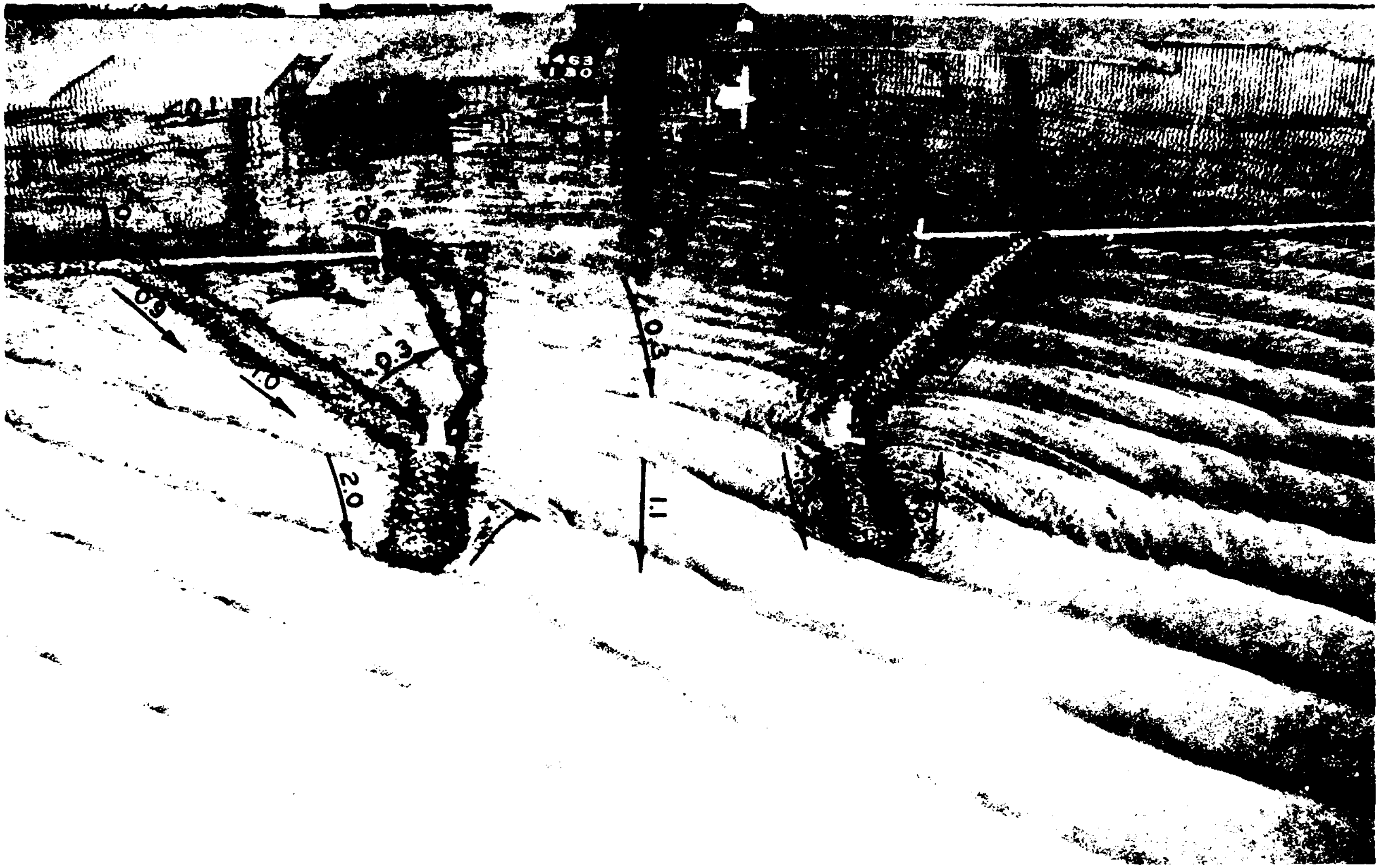



Photo 86. Typical wave patterns, current patterns, and current magnitudes (prototype feet per second) at the west entrance for Fair-Weather Plan 4D; 6-sec, 5.6-ft waves from 326 deg; +4.8 ft swl; river discharge 8,000 cfs


Photo 87. Typical wave patterns, current patterns, and current magnitudes (prototype feet per second) at the west entrance for Fair-Weather Plan 4D; 6-sec, 4.7-ft waves from 17 deg; 0.0-ft swl; river discharge 800 cfs


● INDICATES NO CURRENT MOVEMENT

Photo 88. Typical wave patterns, current patterns, and current magnitudes (prototype feet per second) at the west entrance for Fair-Weather Plan 4D; 6-sec, 4.7-ft waves from 17 deg; 0.0-ft swl; river discharge 8,000 cfs




● INDICATES NO CURRENT MOVEMENT

Photo 89. Typical wave patterns, current patterns, and current magnitudes (prototype feet per second) at the west entrance for Fair-Weather Plan 4D; 8-sec, 9.8-ft waves from 17 deg; 0.0-ft swl; river discharge 800 cfs


Photo 90. Typical wave patterns, current patterns, and current magnitudes (prototype feet per second) at the west entrance for Fair-Weather Plan 4D; 8-sec, 9.8-ft waves from 17 deg; 0.0-ft swl; river discharge 8,000 cfs

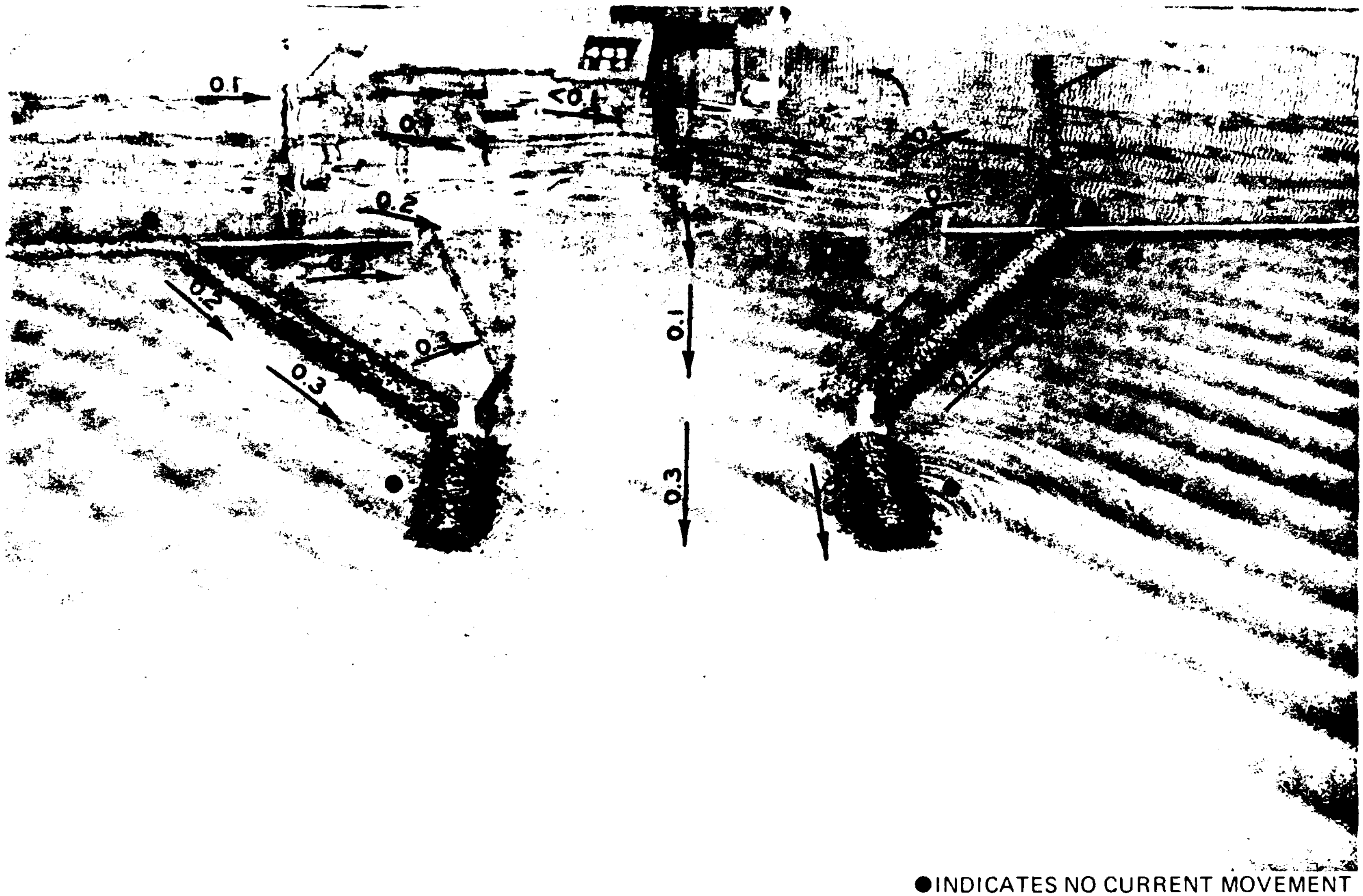



Photo 91. Typical wave patterns, current patterns, and current magnitudes (prototype feet per second) at the west entrance for Fair-Weather Plan 4D; 6-sec, 4.7-ft waves from 17 deg; +2.6 ft swl; river discharge 800 cfs


Photo 92. Typical wave patterns, current patterns, and current magnitudes (prototype feet per second) at the west entrance for Fair-Weather Plan 4D; 6-sec, 4.7-ft waves from 17 deg; +2.6 ft swl; river discharge 8,000 cfs

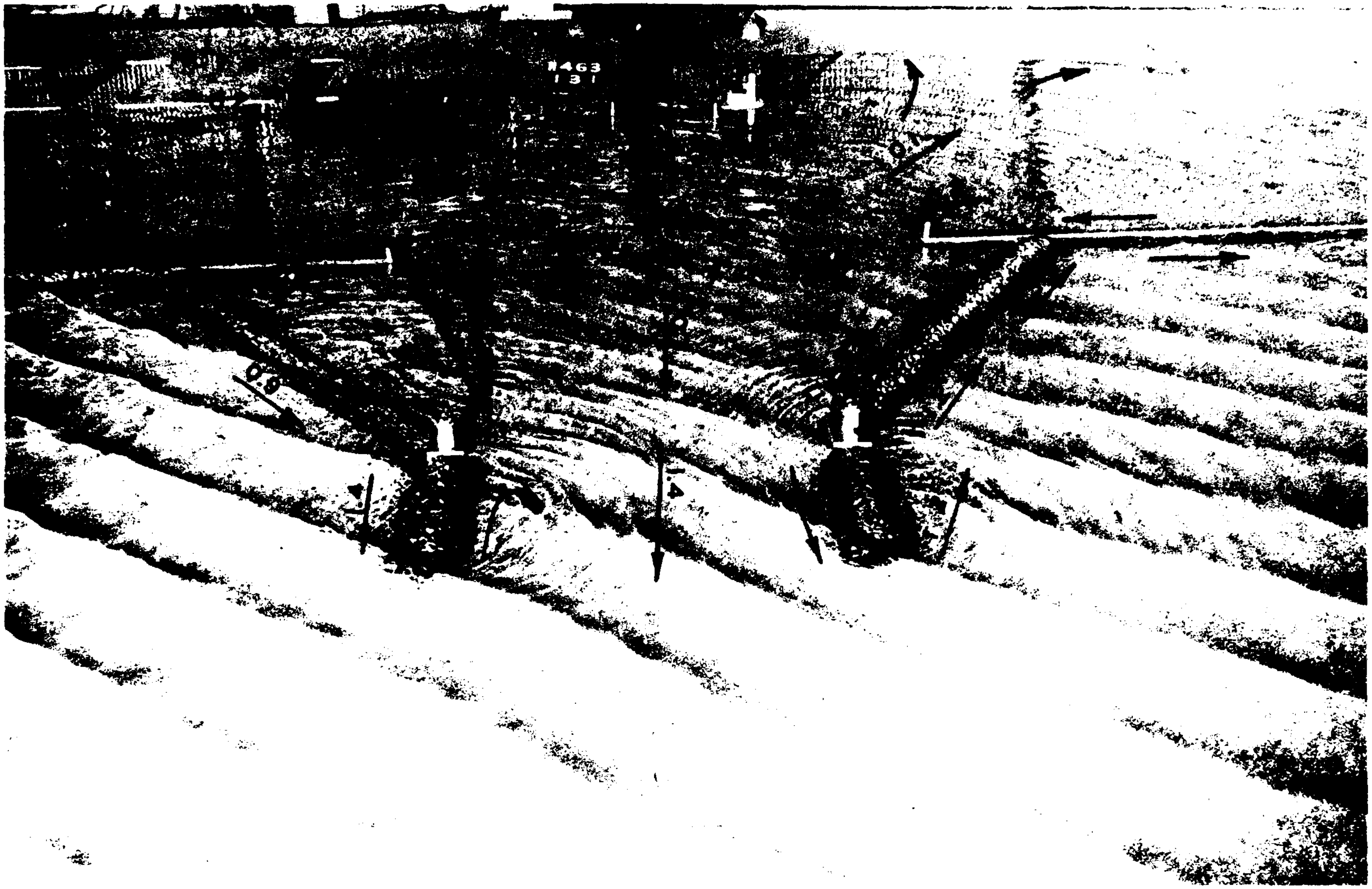



Photo 93. Typical wave patterns, current patterns, and current magnitudes (prototype feet per second) at the west entrance for Fair-Weather Plan 4D; 8-sec, 9.8-ft waves from 17 deg; +2.6 ft swl; river discharge 800 cfs


Photo 94. Typical wave patterns, current patterns, and current magnitudes (prototype feet per second) at the west entrance for Fair-Weather Plan 4D; 8-sec, 9.8-ft waves from 17 deg; +2.6 ft swl; river discharge 8,000 cfs

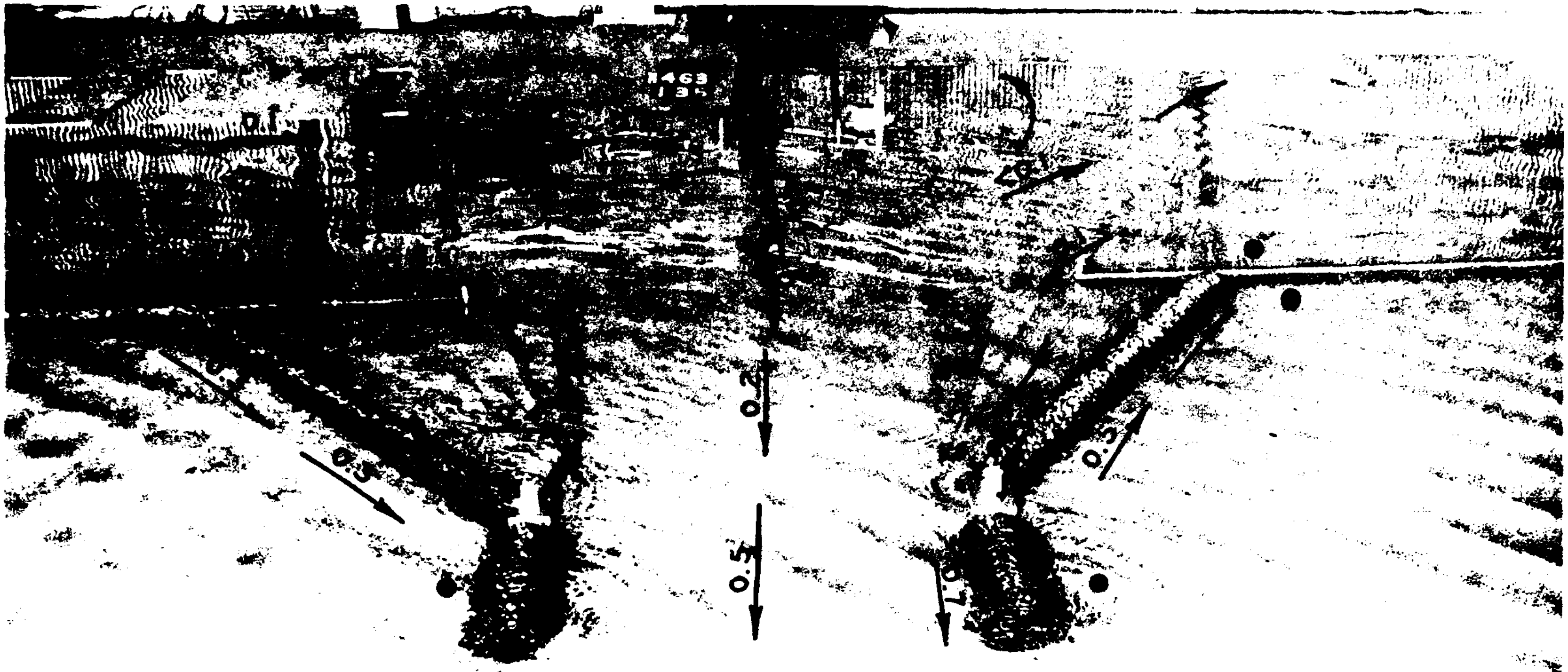



Photo 95. Typical wave patterns, current patterns, and current magnitudes (prototype feet per second) at the west entrance for Fair-Weather Plan 4D; 6-sec, 4.7-ft waves from 17 deg; +4.8 ft swl; river discharge 800 cfs

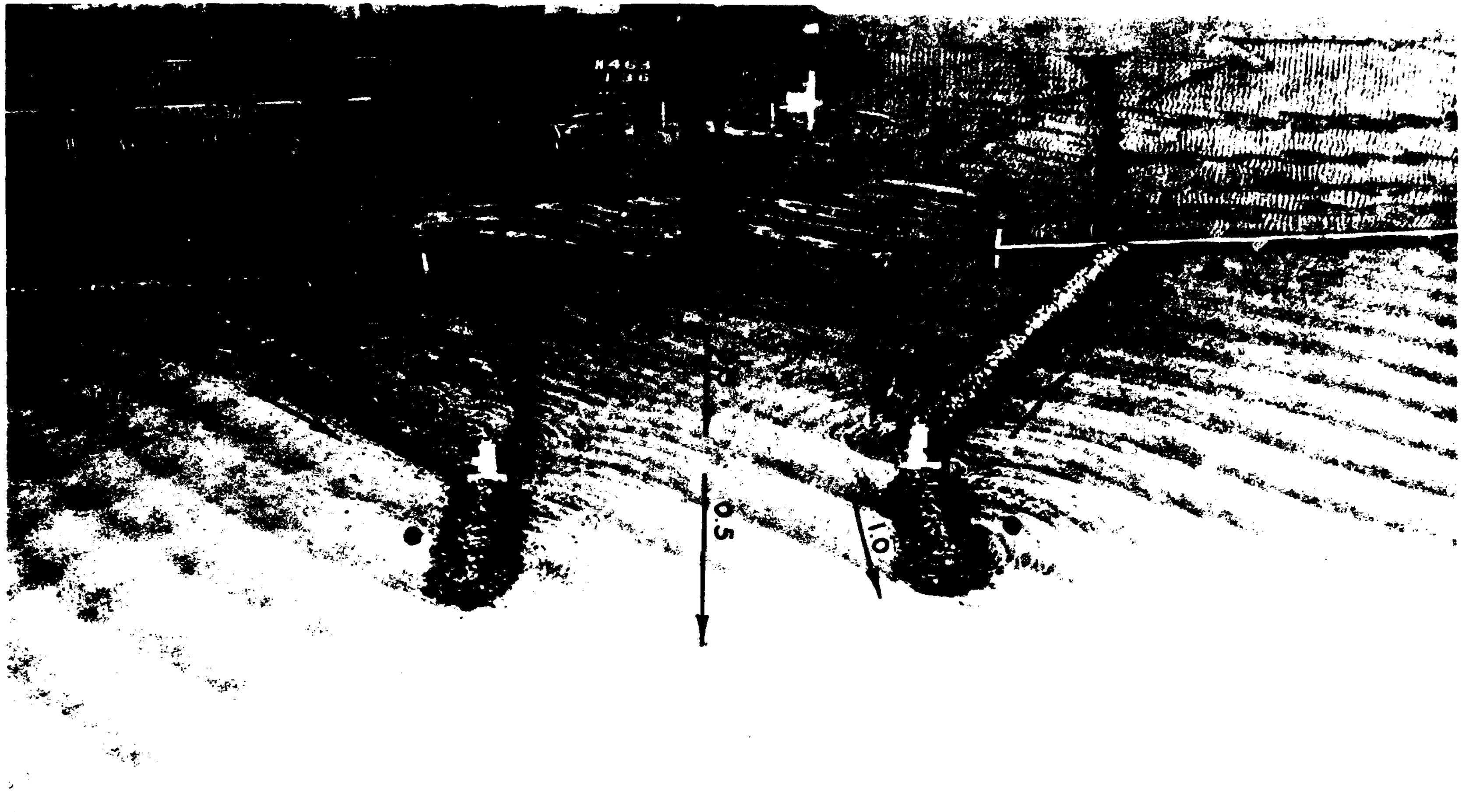



Photo 96. Typical wave patterns, current patterns, and current magnitudes (prototype feet per second) at the west entrance for Fair-Weather Plan 4D; 6-sec, 4.7-ft waves from 17 deg; +4.8 ft swl; river discharge 8,000 cfs


Photo 97. Typical wave patterns, current patterns, and current magnitudes (prototype feet per second) at the west entrance for Fair-Weather Plan 4D; 8-sec, 9.8-ft waves from 17 deg; +4.8 ft swl; river discharge 800 cfs

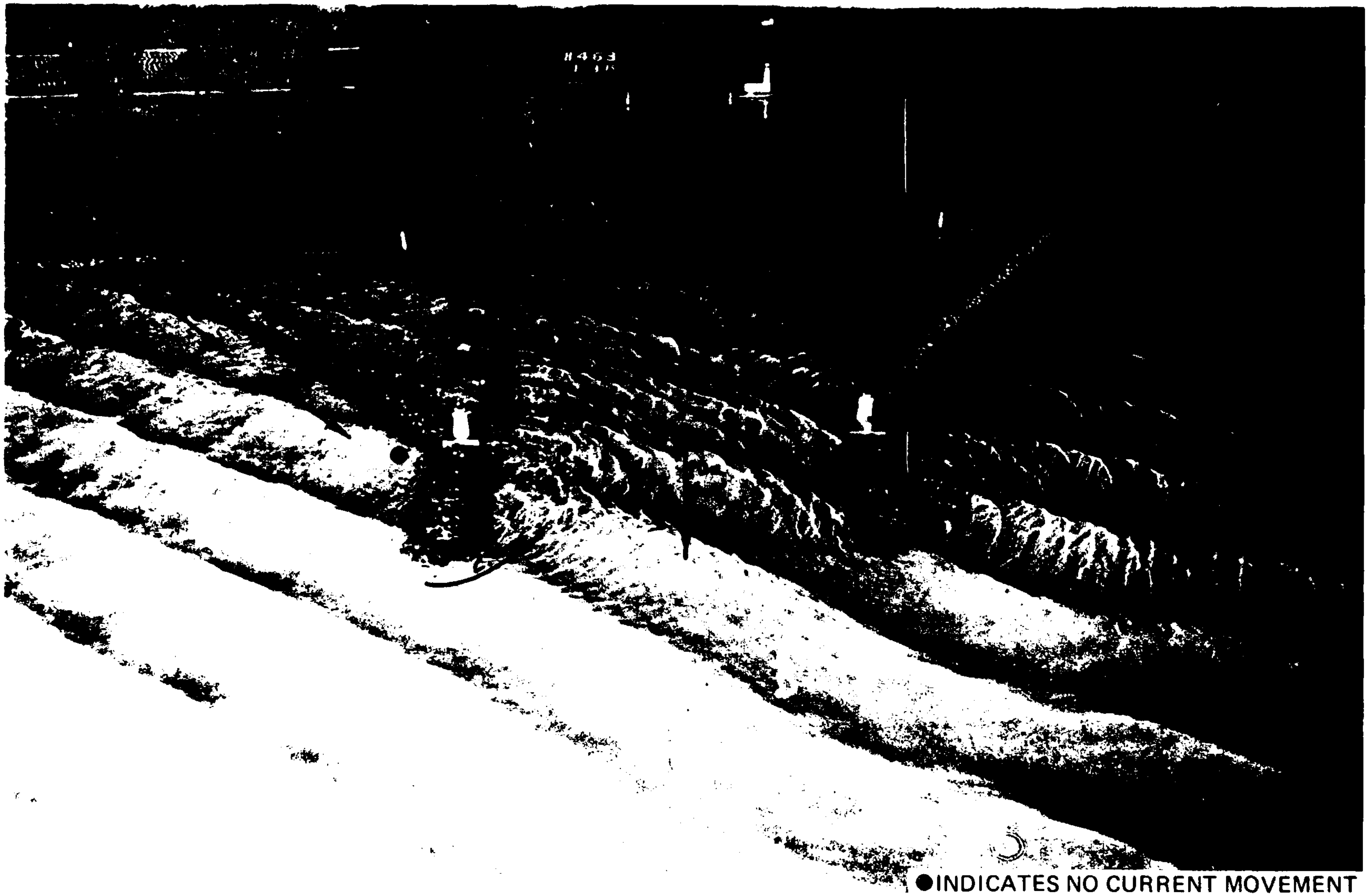



Photo 98. Typical wave patterns, current patterns, and current magnitudes (prototype feet per second) at the west entrance for Fair-Weather Plan 4D; 8-sec, 9.8-ft waves from 17 deg; +4.8 ft swl; river discharge 8,000 cfs

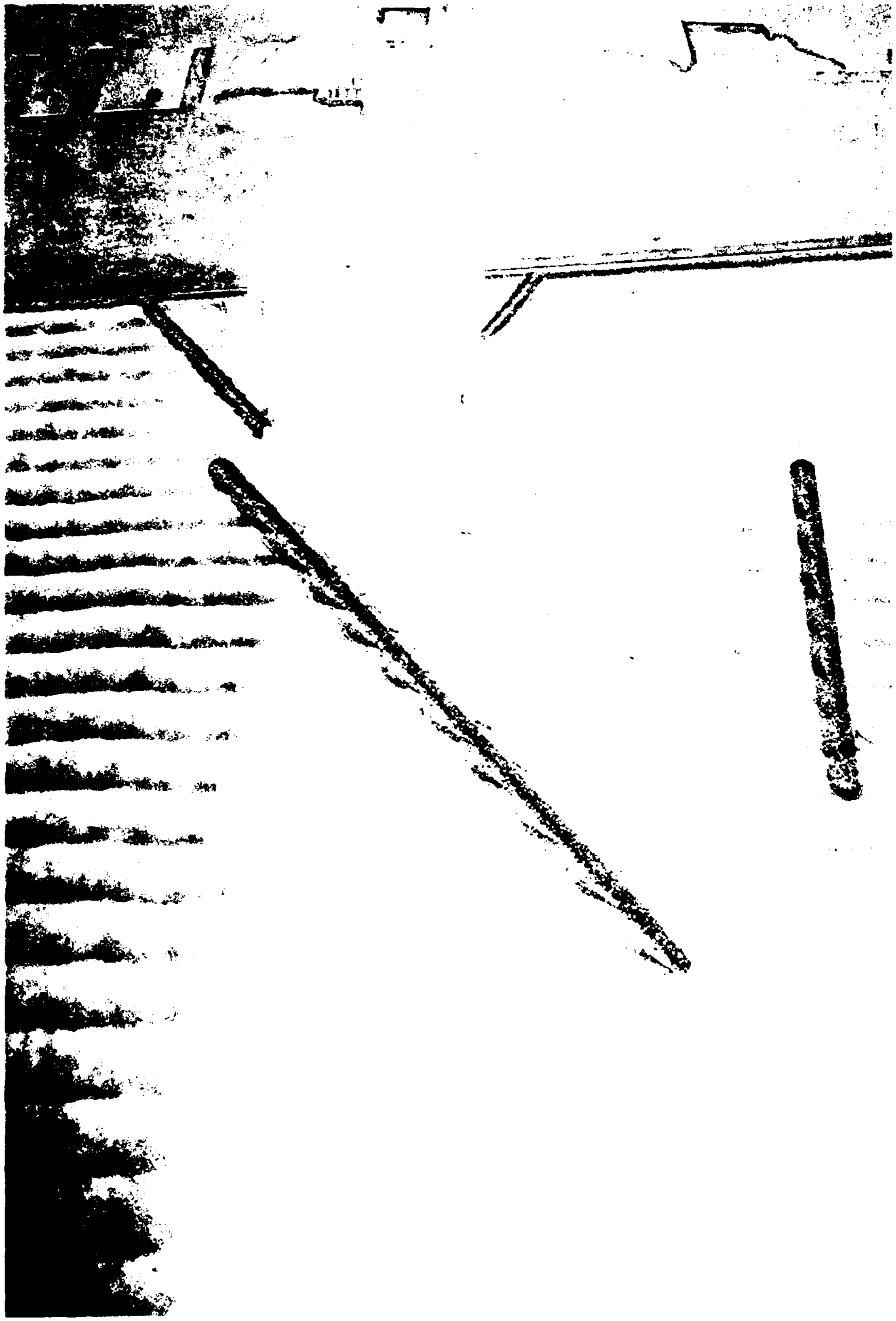


Photo 99. Typical wave patterns for Severe-Weather Plan 6; 7-sec, 8-ft waves from 326 deg; +4.8 ft swl; river discharge 800 cfs

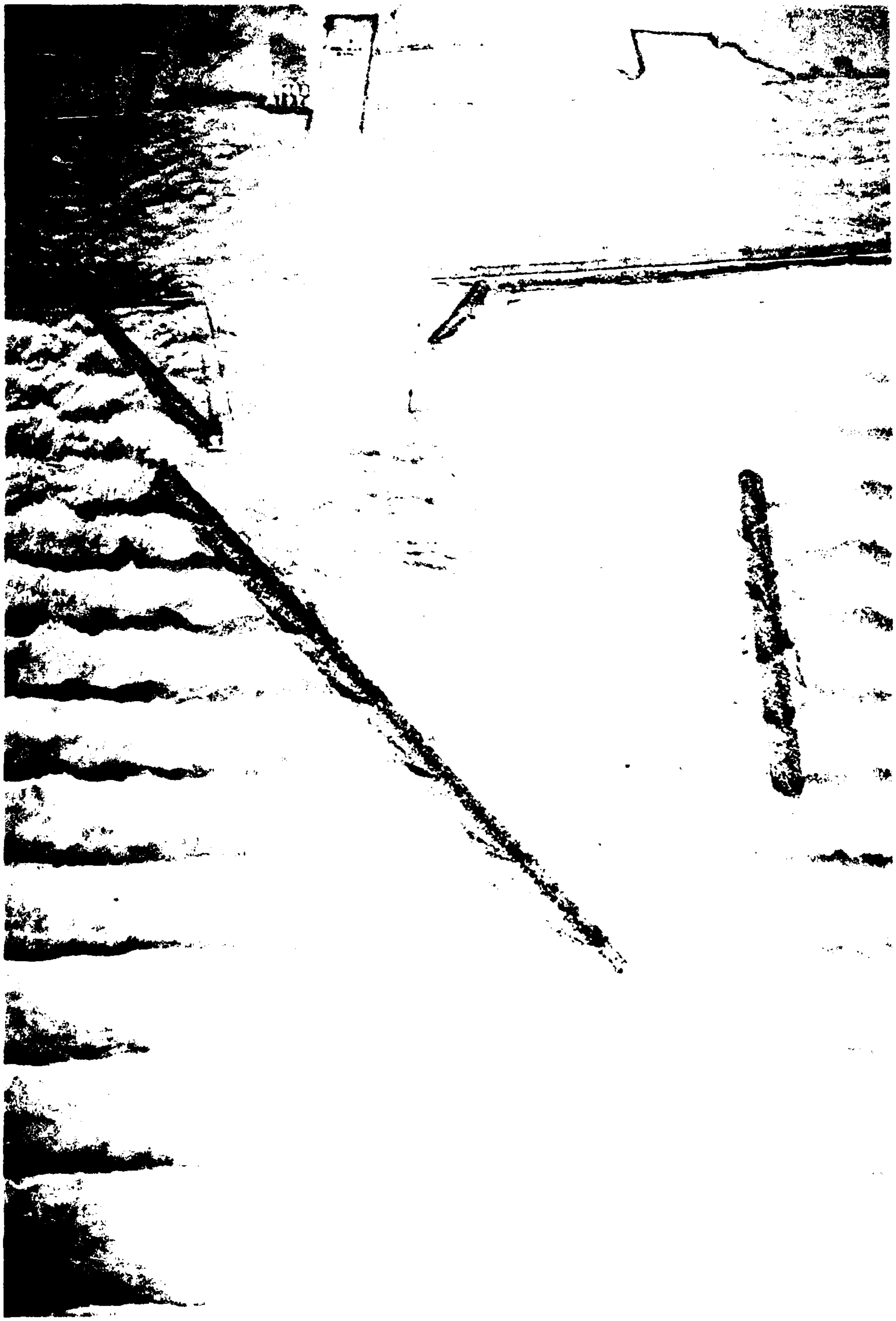


Photo 100. Typical wave patterns for Severe-Weather Plan 6; 10-sec, 13.7-ft waves from 326 deg; +4.8 ft swl; river discharge 800 cfs

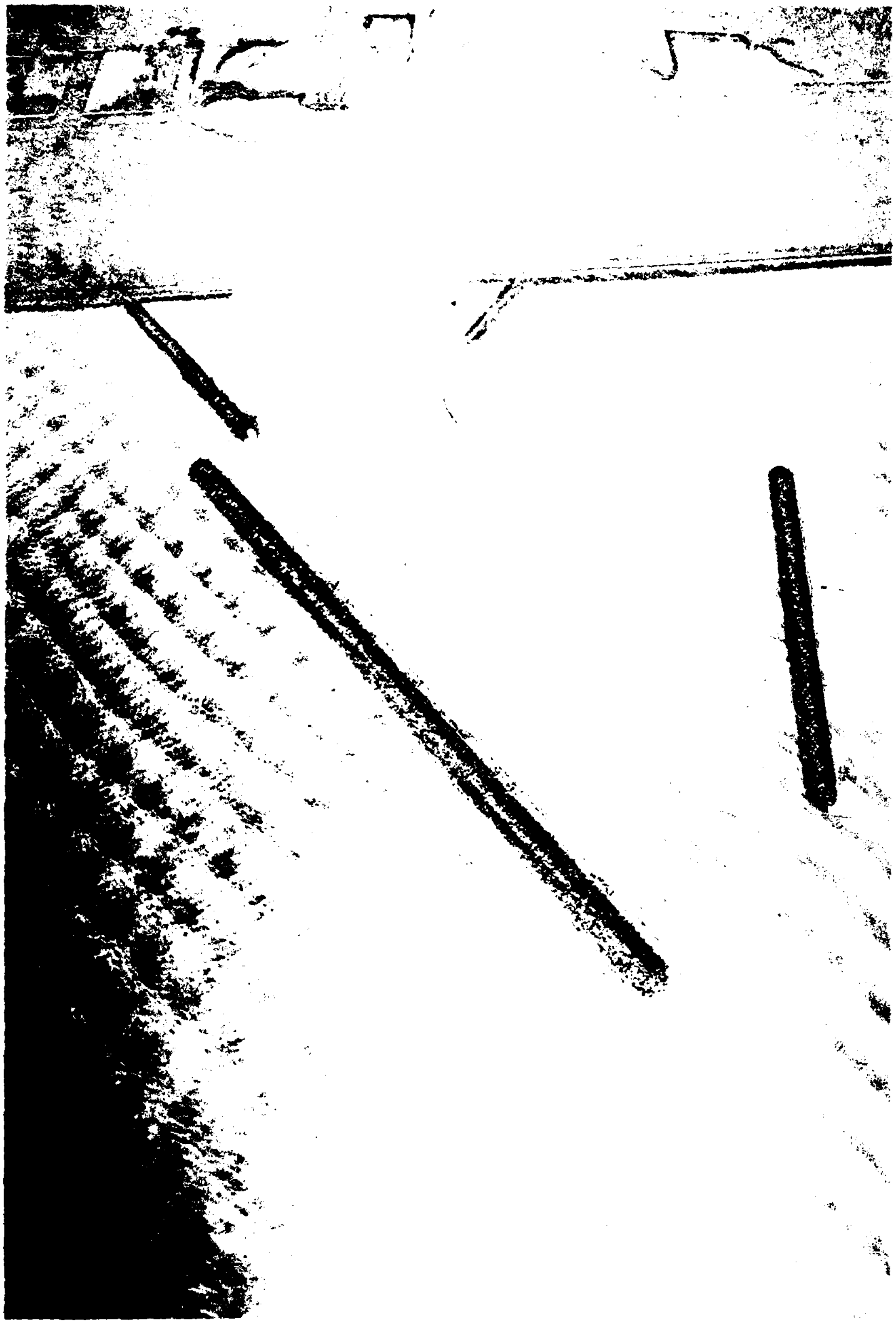


Photo 101. Typical wave patterns for Severe-Weather Plan 6; 7-sec, 7.3-ft waves from 17 deg; +4.8 ft swl; river discharge 800 cfs

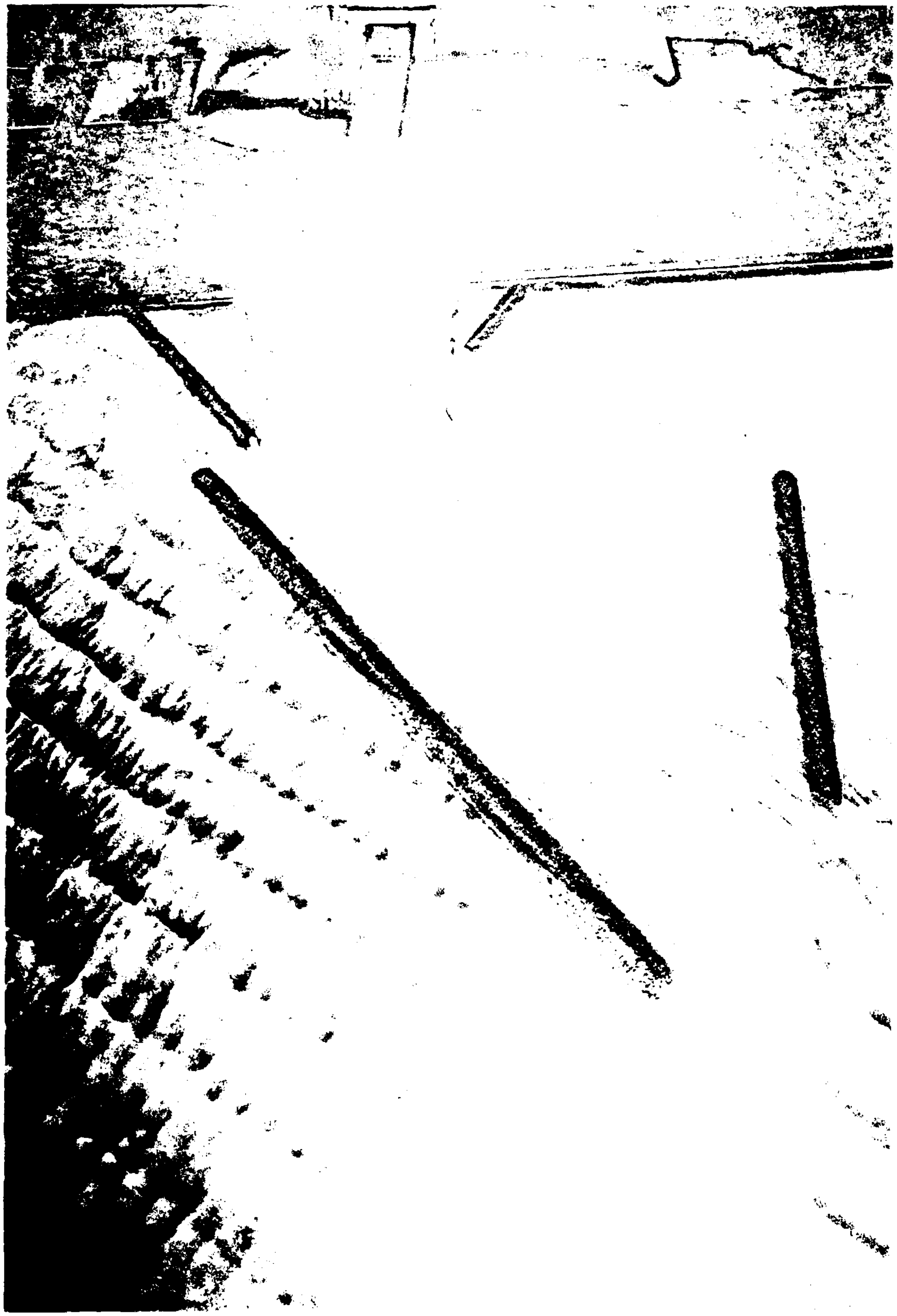


Photo 102. Typical wave patterns for Severe-Weather Plan 6, 9.5-sec, 12.2-ft waves from 17 deg; +4.8 ft swl; river discharge 800 cfs

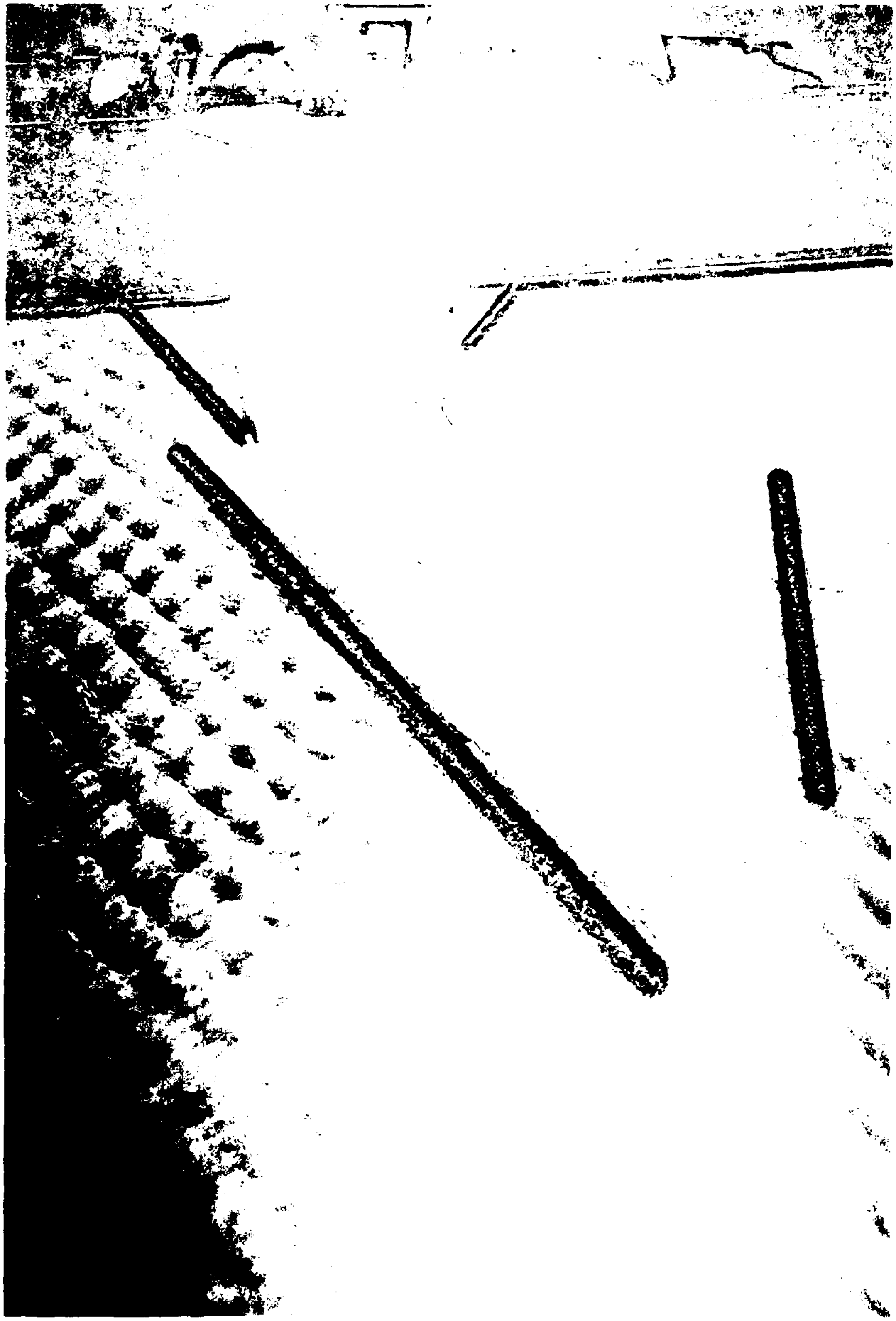


Photo 103. Typical wave patterns for Severe-Weather Plan 6A; 7-sec, 7.3-ft waves from 17 deg; +4.8 ft swl; river discharge 800 cfs

Photo 104. Typical wave patterns for Severe-Weather Plan 6A; 9.5-sec, 12.2-ft waves from 17 deg; +4.8 ft swl; river discharge 800 cfs

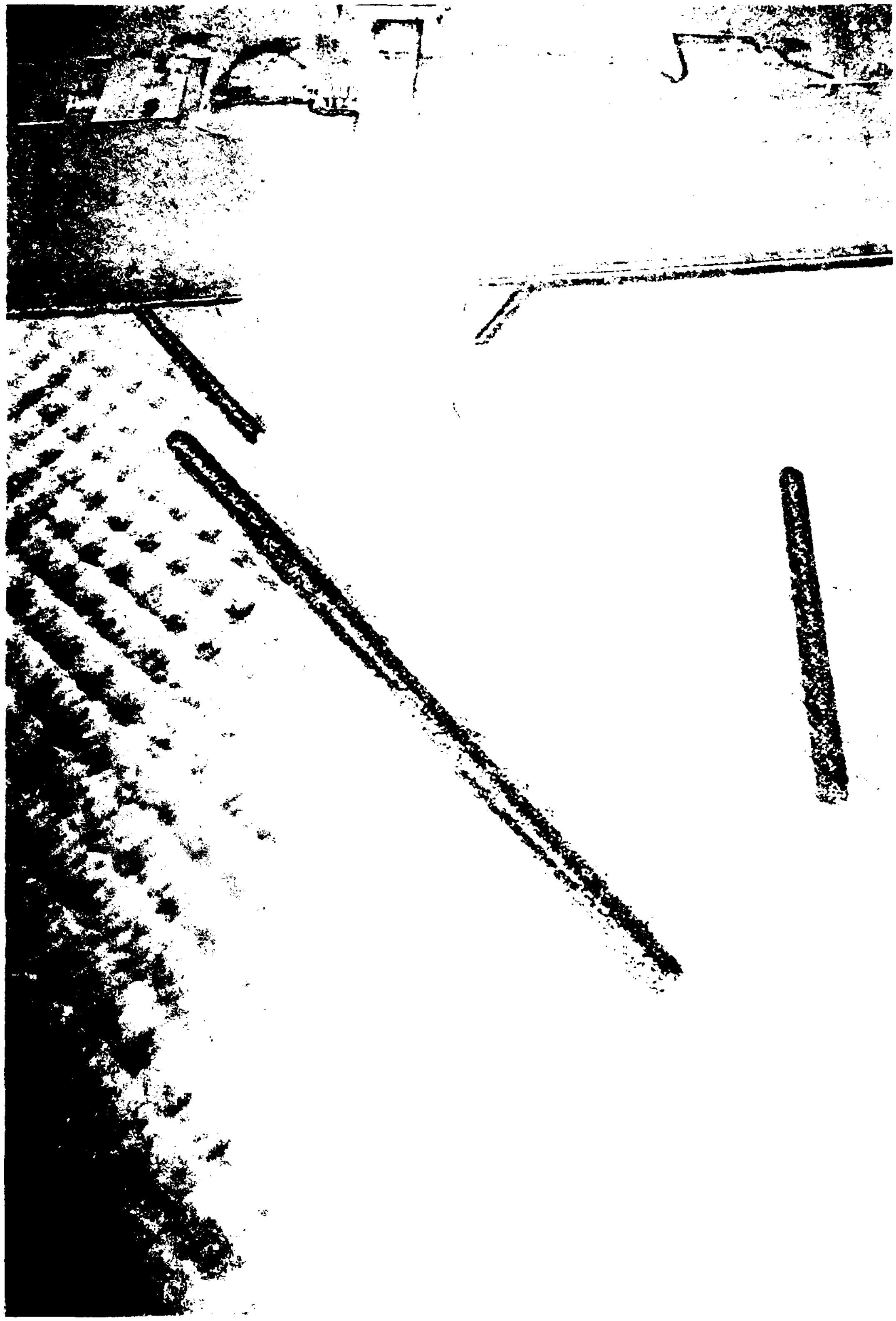


Photo 105. Typical wave patterns for Severe-Weather Plan 6B; 7-sec, 7.3-ft waves from 17 deg; +4.8 ft swl; river discharge 800 cfs

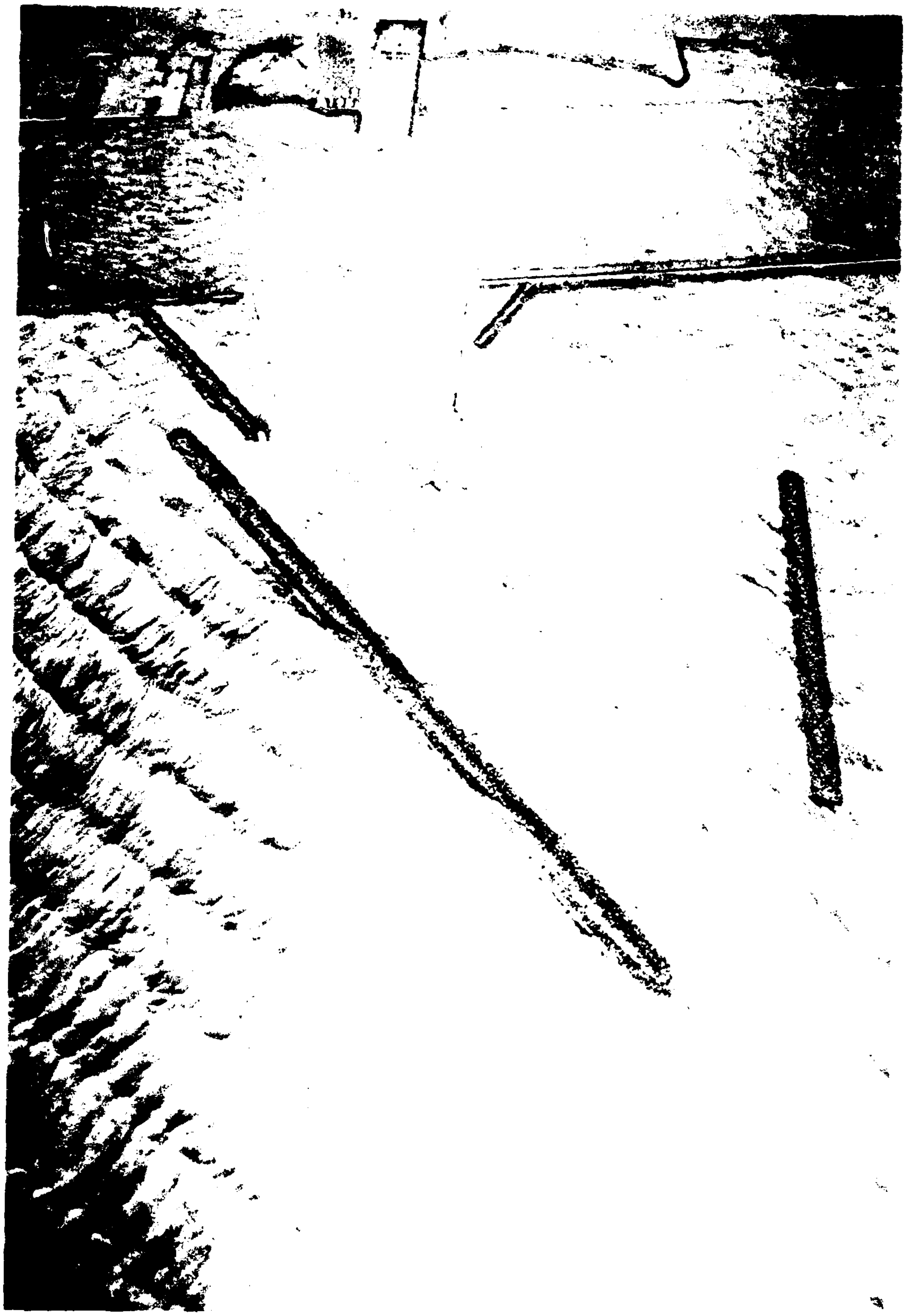


Photo 106. Typical wave patterns for Severe-Weather Plan 6B; 9.5-sec, 12.2-ft waves from 17 deg; +4.8 ft swl; river discharge 800 cfs

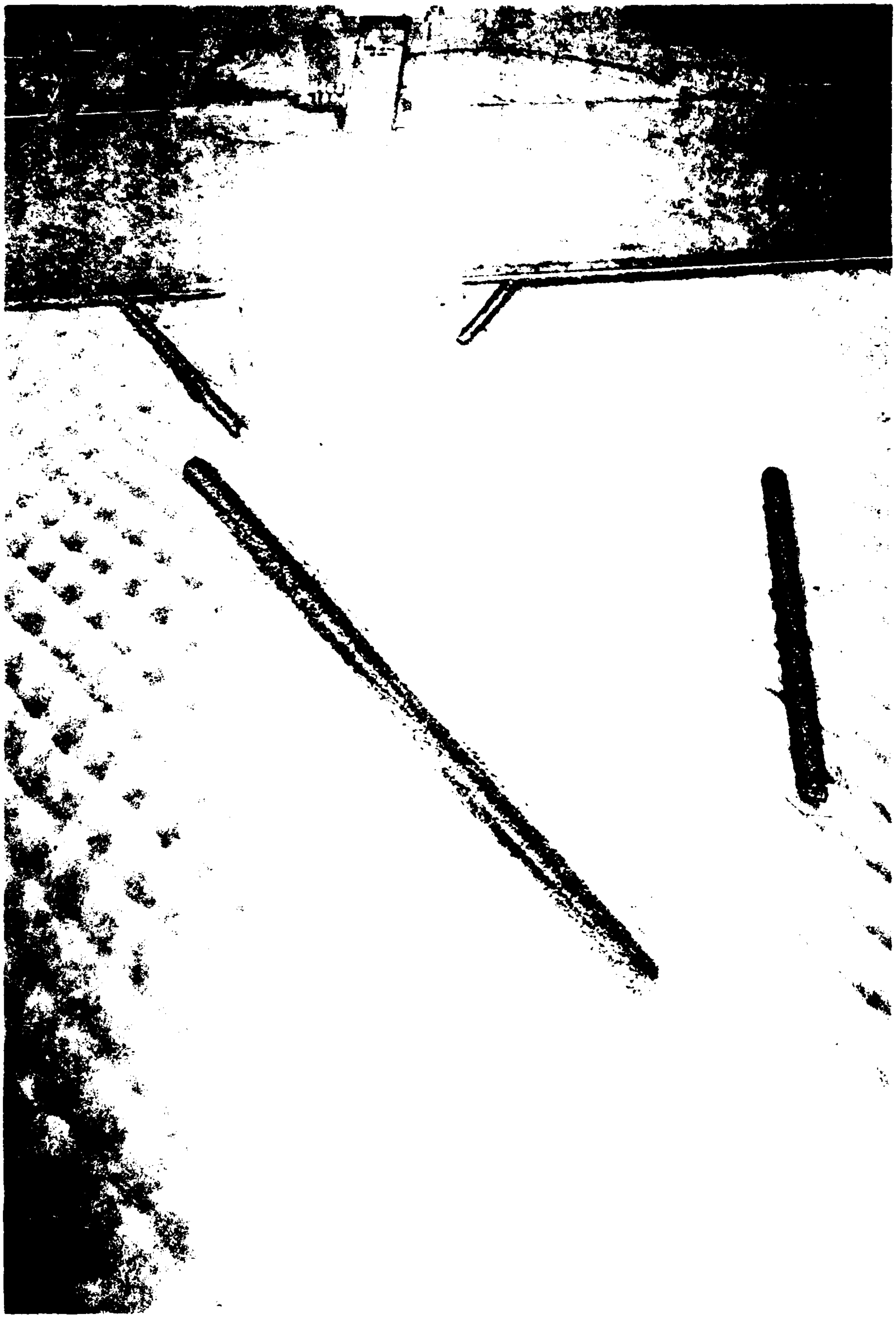


Photo 107. Typical wave patterns for Severe-Weather Plan 6C; 7-sec, 7.3-ft waves from 17 deg; +4.8 ft swl; river discharge 800 cfs

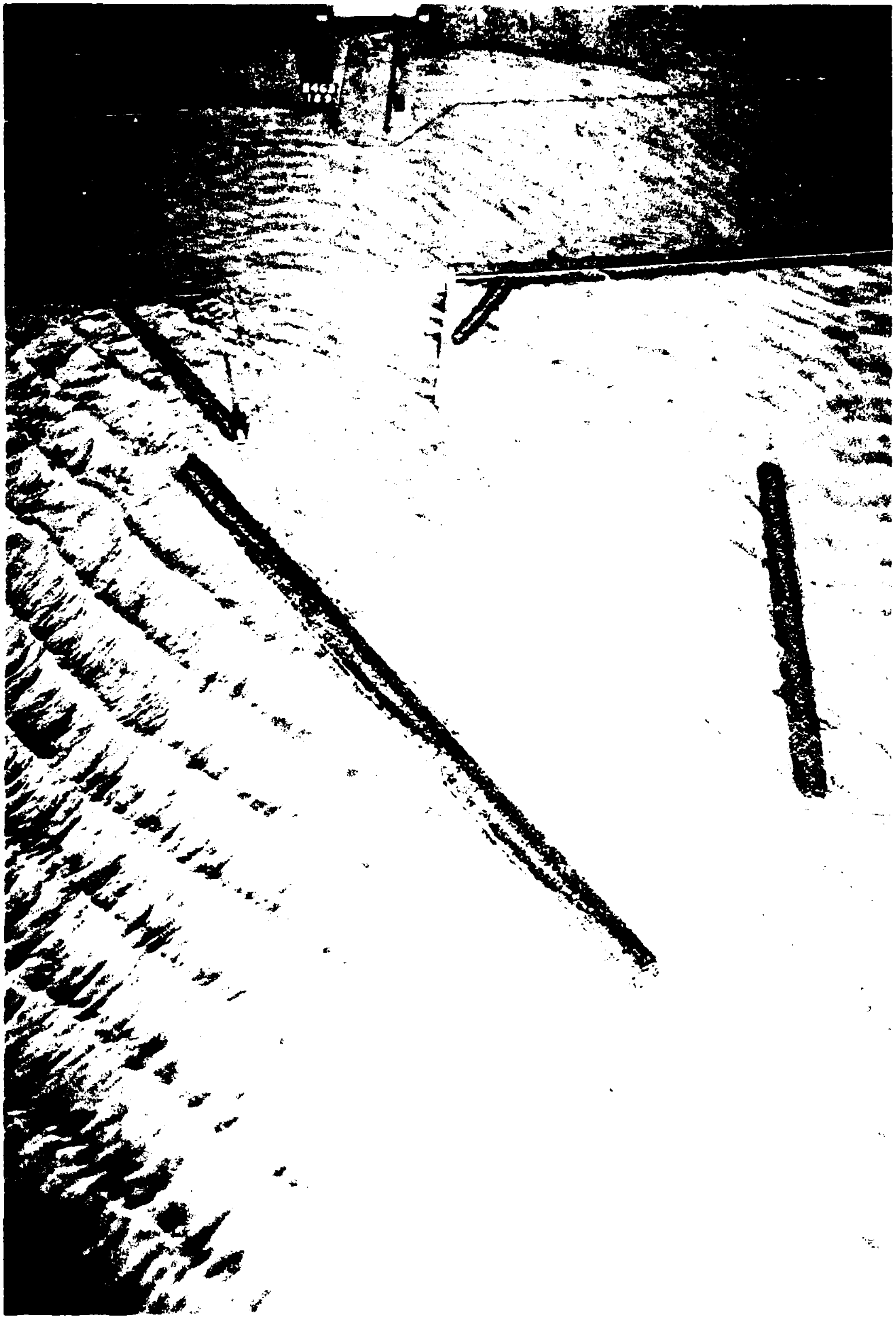


Photo 108. Typical wave patterns for Severe-Weather Plan 6C; 9.5-sec, 12.2-ft waves from 17 deg; +4.8 ft swl; river discharge 800 cfs

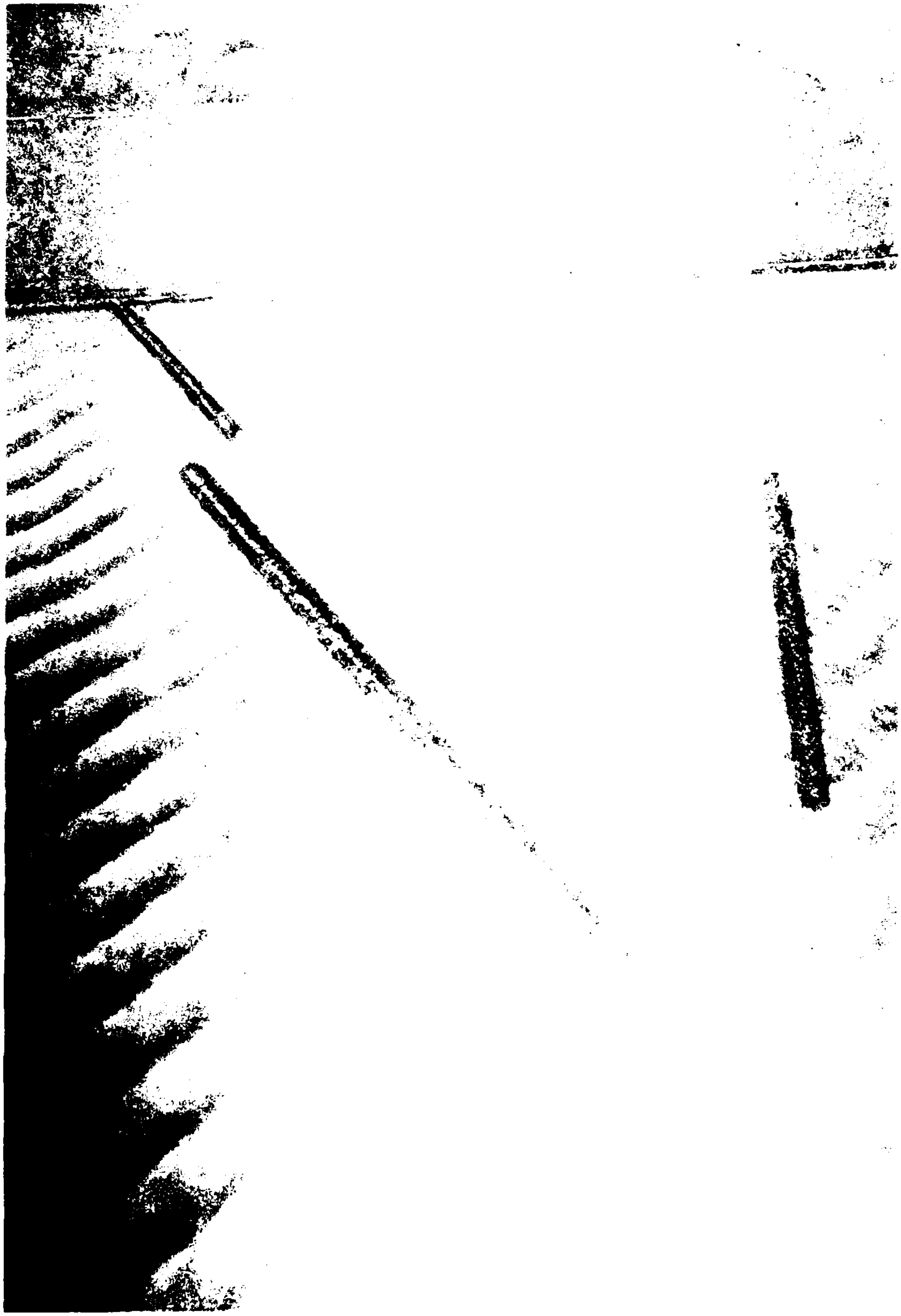


Photo 109. Typical wave patterns for Severe-Weather Plan 6C; 8-sec, 6.6-ft waves from 279 deg; +4.8 ft swl; river discharge 800 cfs

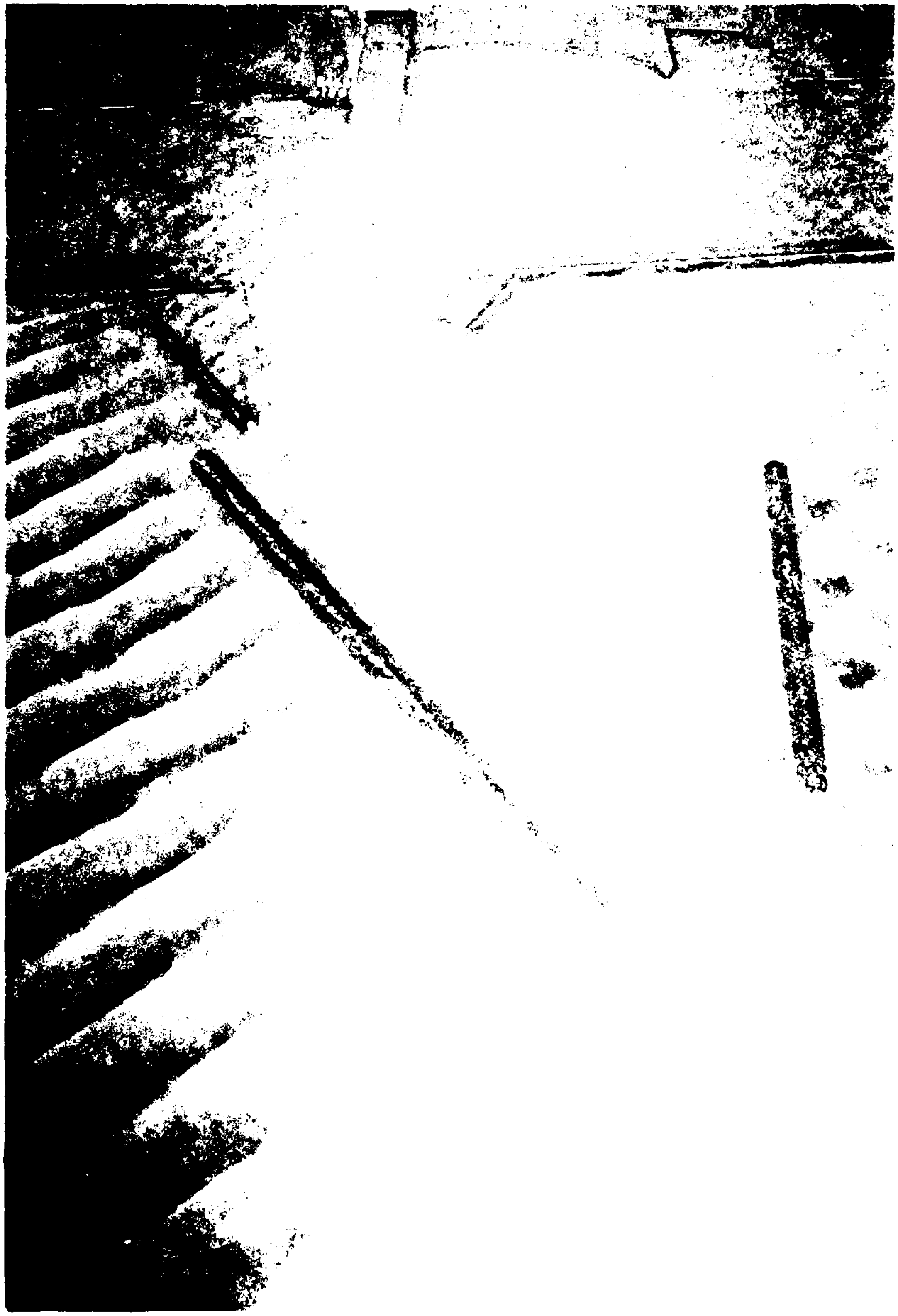


Photo 110. Typical wave patterns for Severe-Weather Plan 6C; 10-sec, 9.2-ft waves from 279 deg; +4.8 ft swl; river discharge 800 cfs

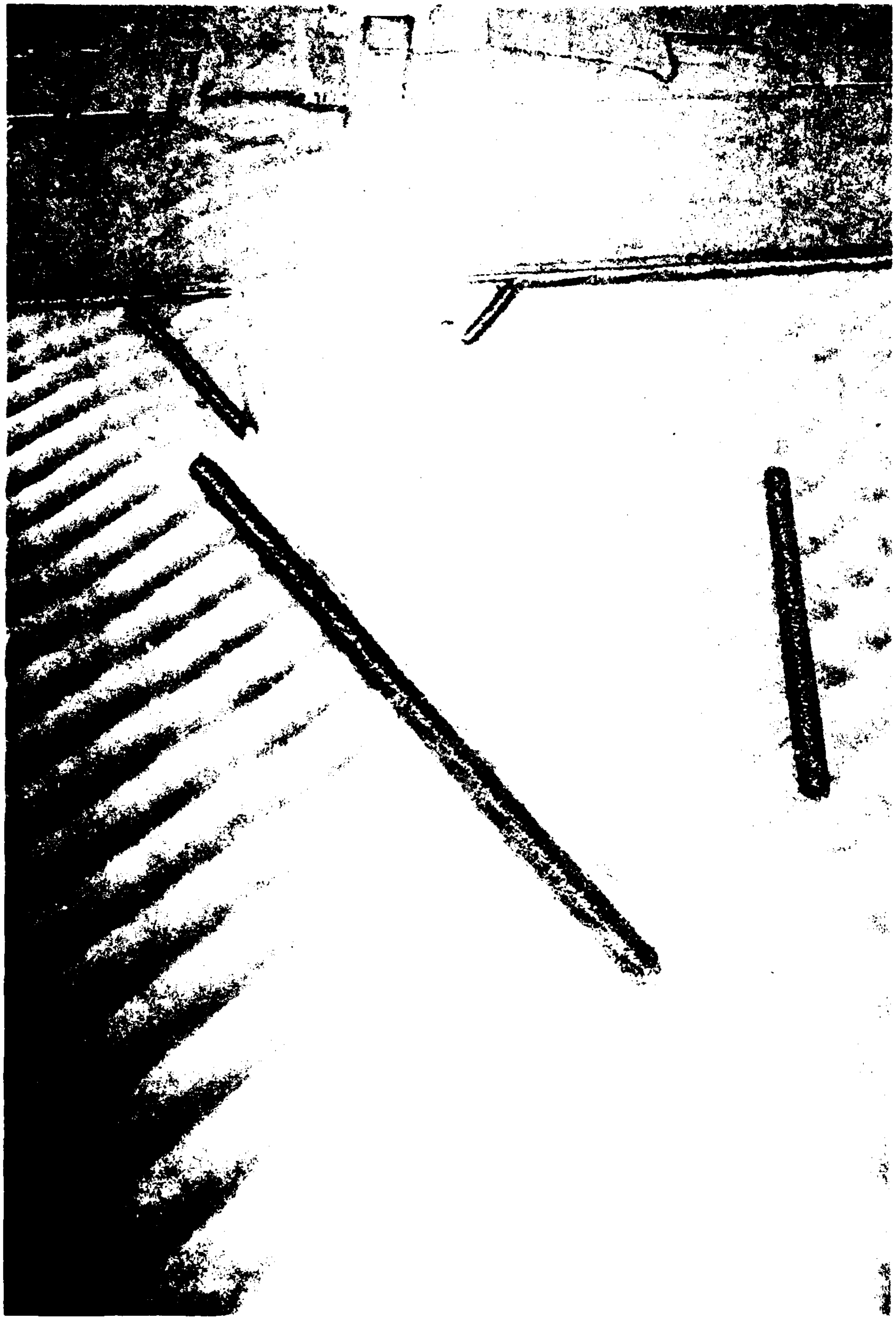


Photo 111. Typical wave patterns for Severe-Weather Plan 7; 8-sec, 6.6-ft waves from 279 deg; +4.8 ft swl; river discharge 800 cfs

Photo 112. Typical wave patterns for Severe-Weather Plan 7; 10-sec, 9.2-ft waves from 279 deg; +4.8 ft swl; river discharge 800 cfs

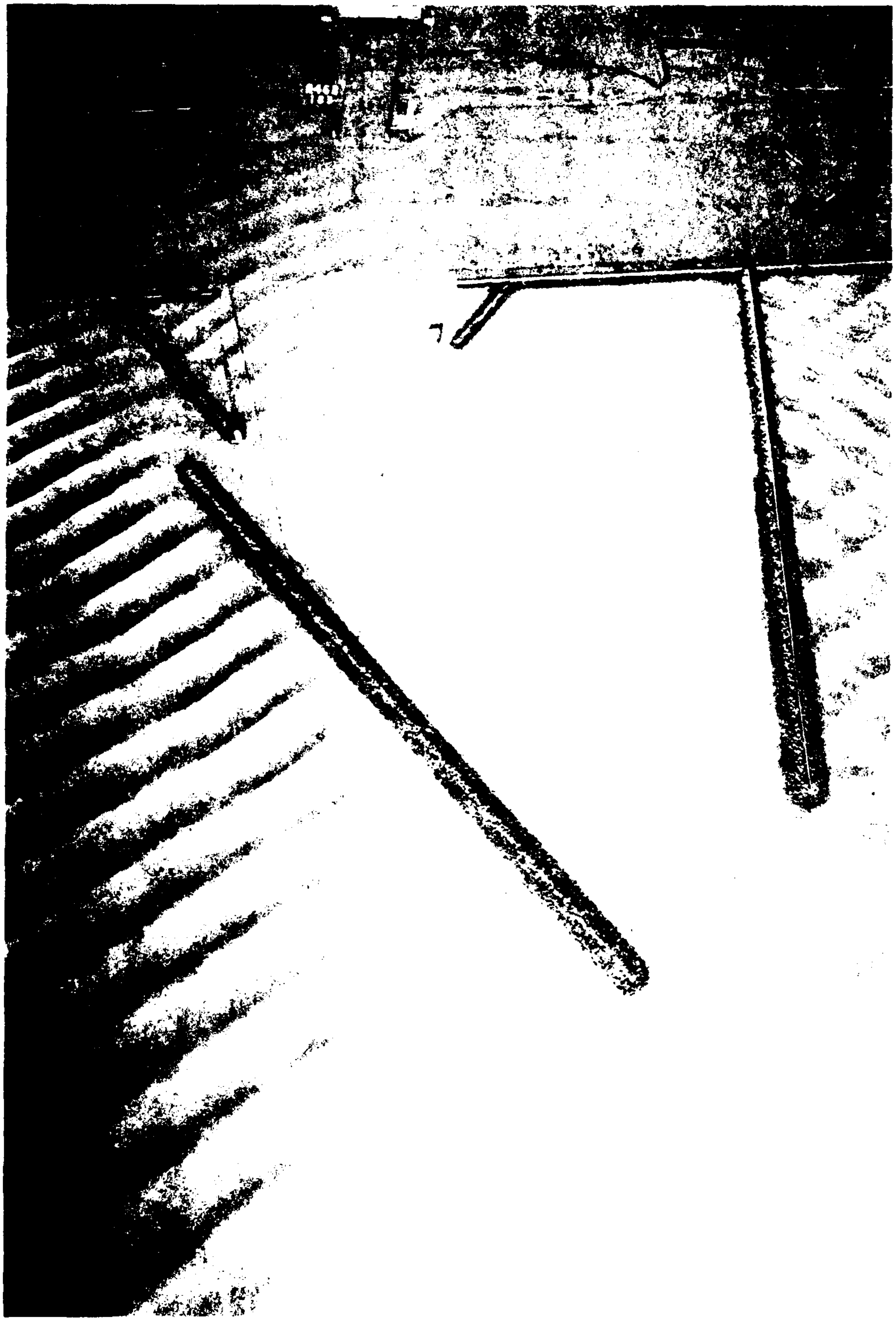


Photo 113. Typical wave patterns for Severe-Weather Plan 8; 8-sec, 6.6-ft waves from 279 deg; +4.8 ft swl; river discharge 800 cfs

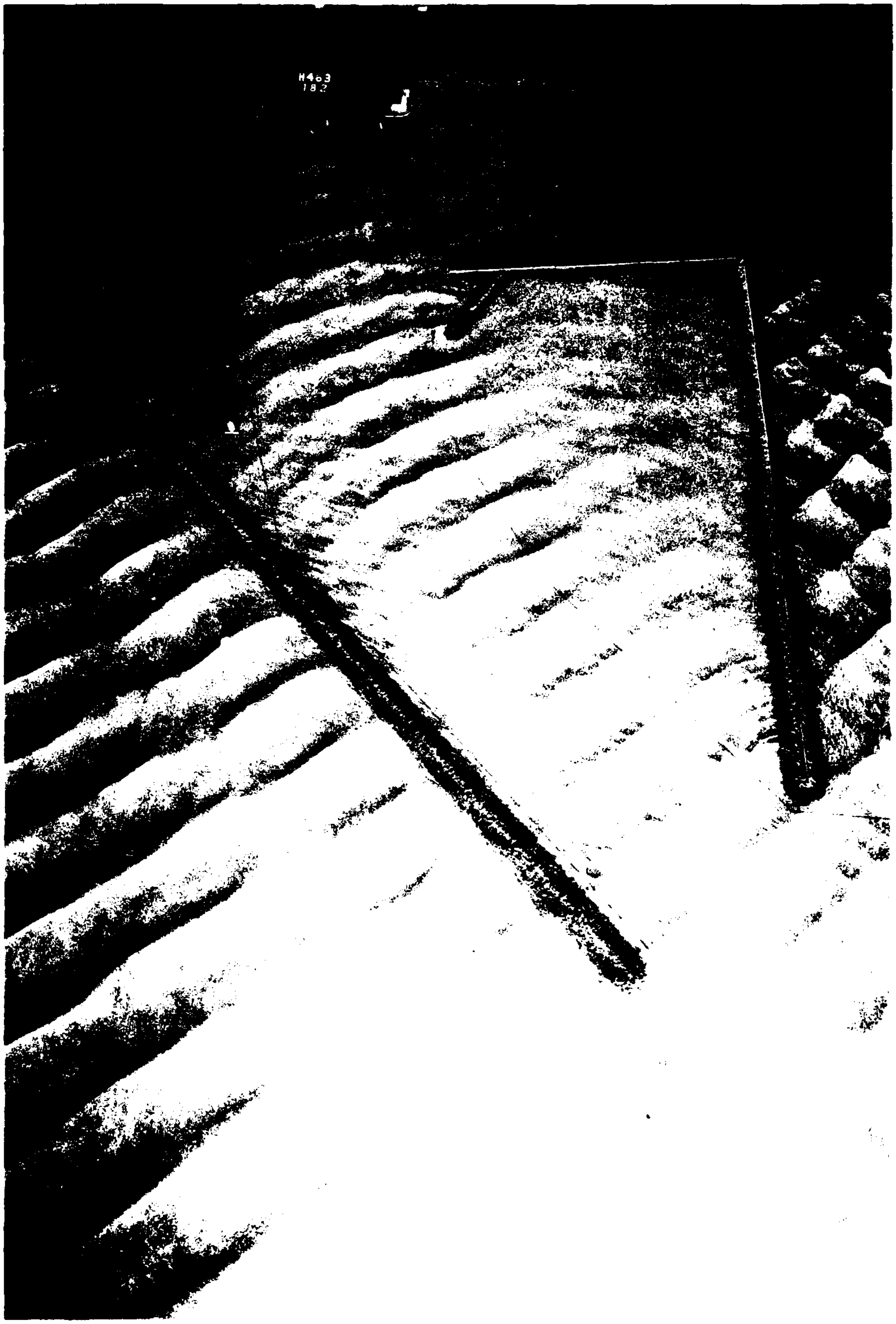


Photo 114. Typical wave patterns for Severe-Weather Plan 8; 10-sec, 9.2-ft waves from 279 deg; +4.8 ft swl; river discharge 800 cfs

Photo 115. Typical wave patterns for Severe-Weather Plan 9; 8-sec, 6.6-ft waves from 279 deg; +4.8 ft swl; river discharge 800 cfs

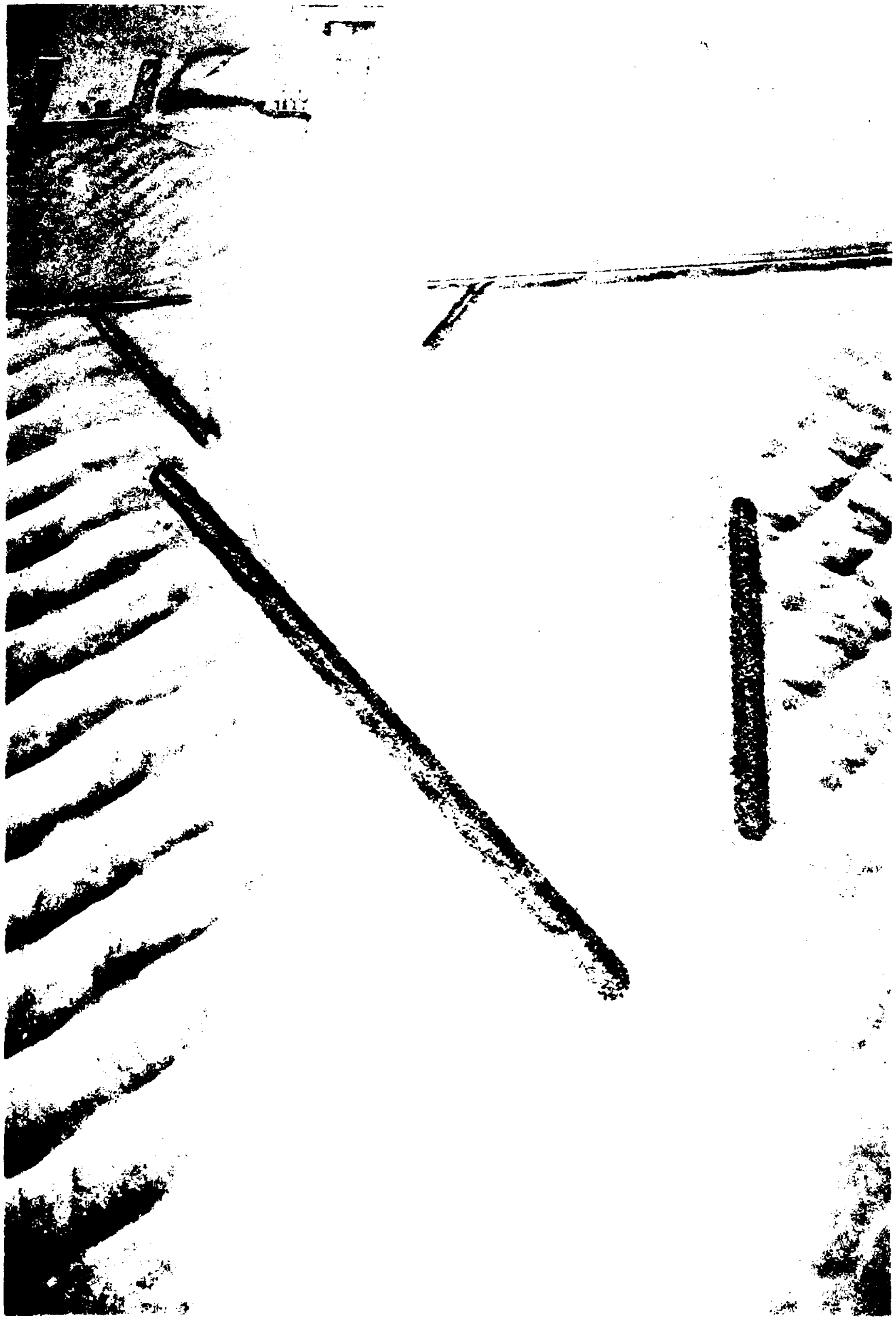


Photo 116. Typical wave patterns for Severe-Weather Plan 9; 10-sec, 9.2-ft waves from 279 deg; +4.8 ft swl; river discharge 800 cfs

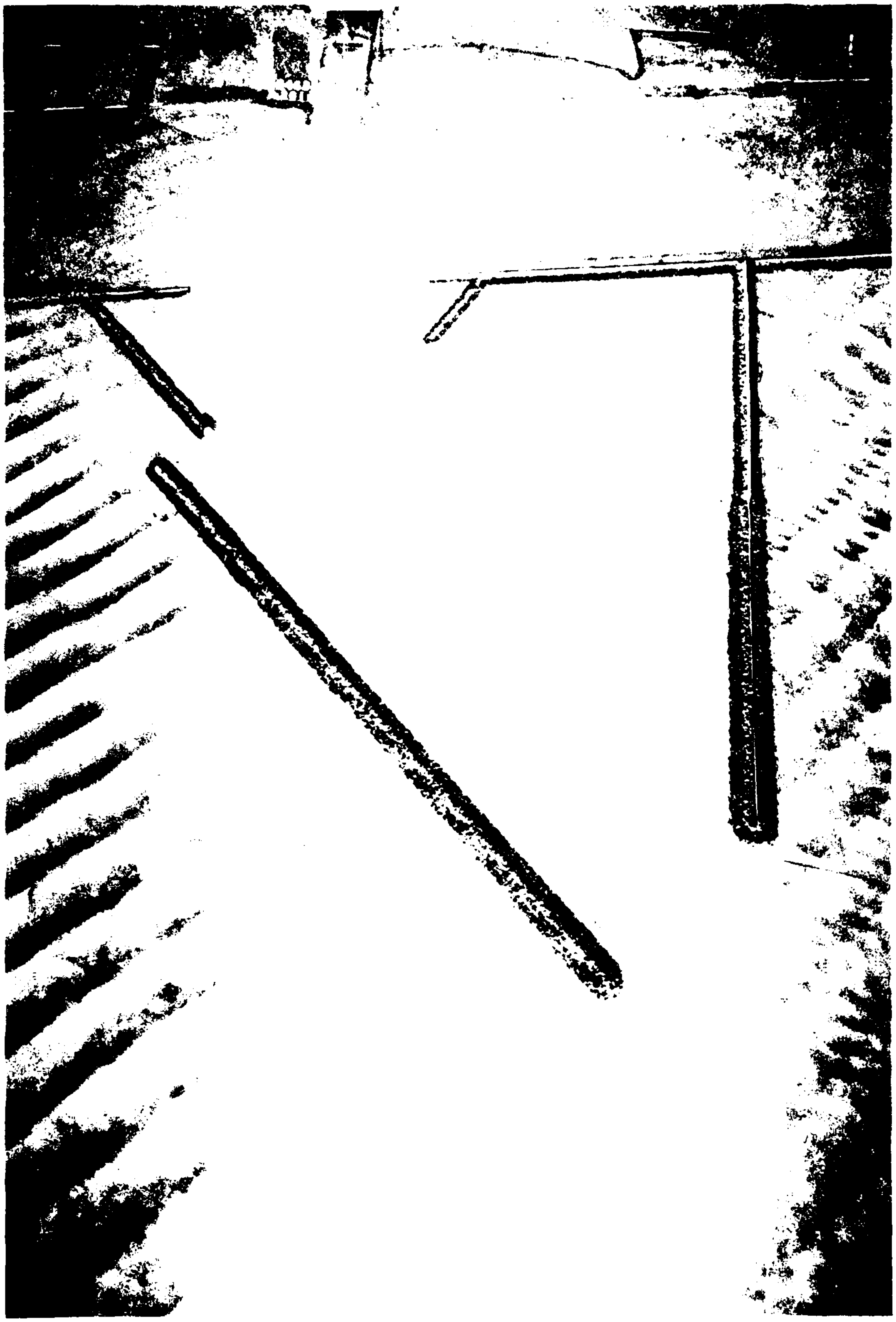


Photo 117. Typical wave patterns for Severe-Weather Plan 9A; 8-sec, 6.6-ft waves from 279 deg; +4.8 ft swl; river discharge 800 cfs

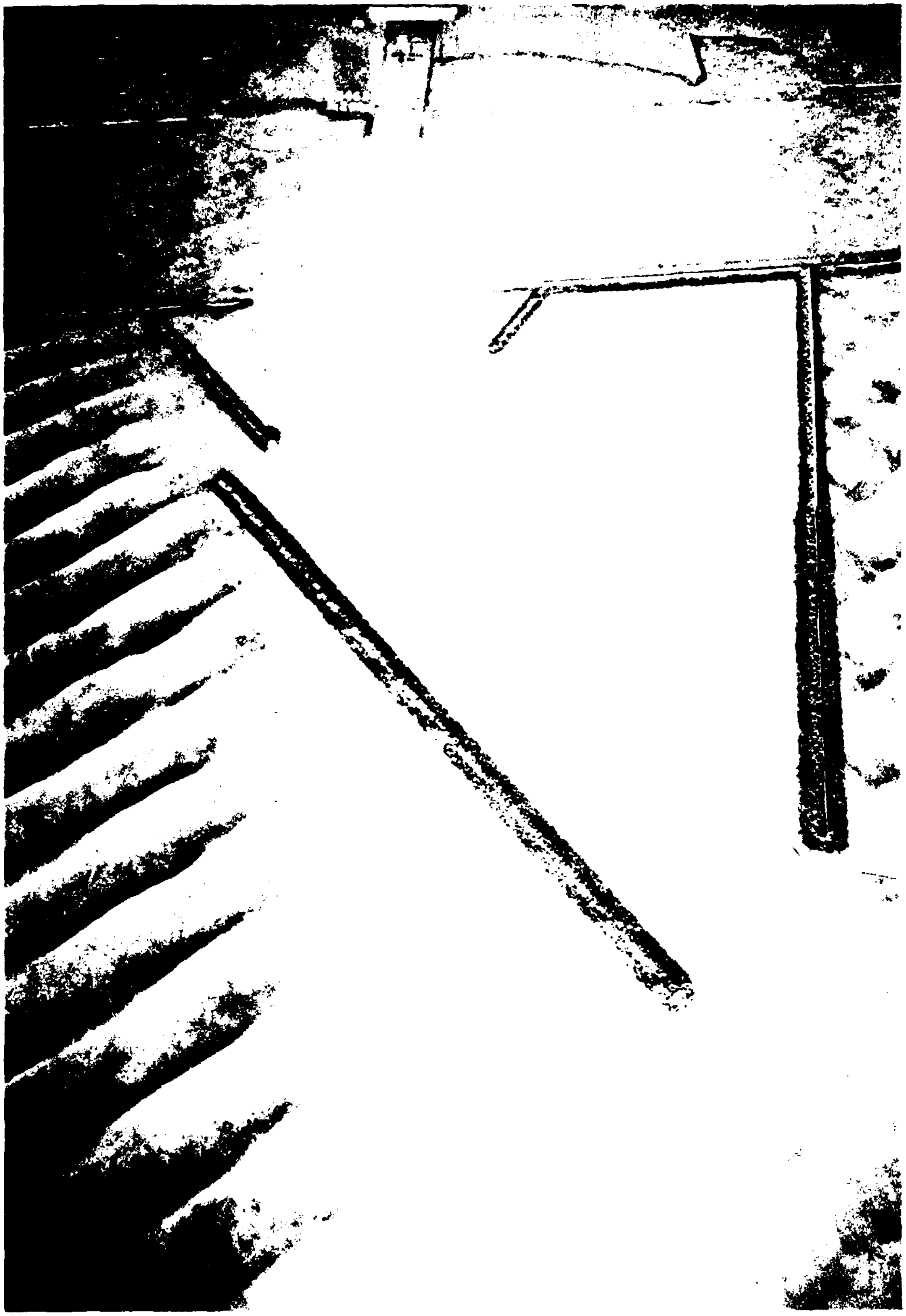


Photo 118. Typical wave patterns for Severe-Weather Plan 9A; 10-sec, 9.2-ft waves from 279 deg; +4.8 ft swl; river discharge 800 cfs

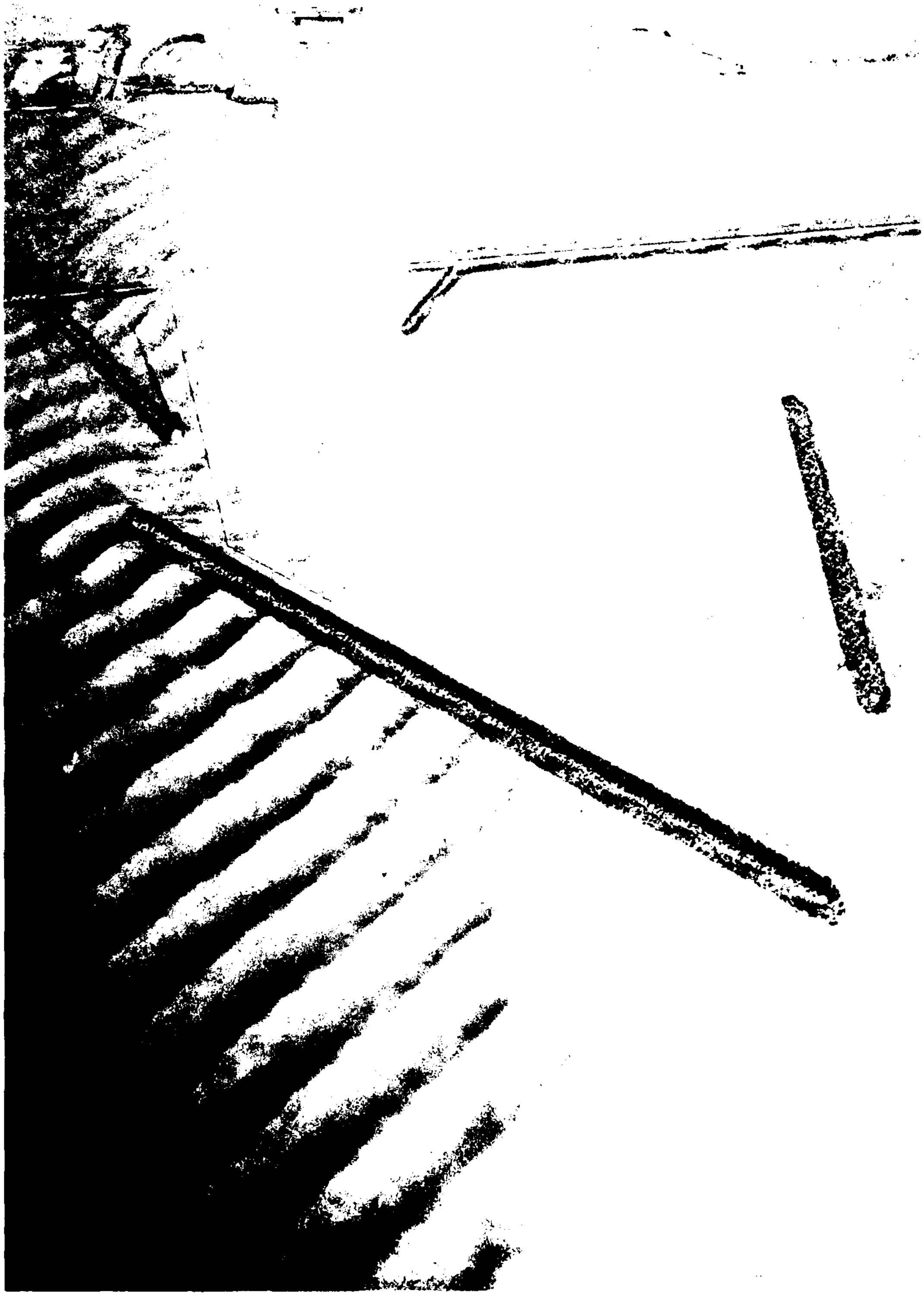


Photo 119. Typical wave patterns for Severe-Weather Plan 10; 8-sec, 6.6-ft waves from 279 deg; +4.8 ft swl; river discharge 800 cfs

Photo 120. Typical wave patterns for Severe-Weather Plan 10; 10-sec, 9.2-ft waves from 279 deg; +4.8 ft swl; river discharge 800 cfs

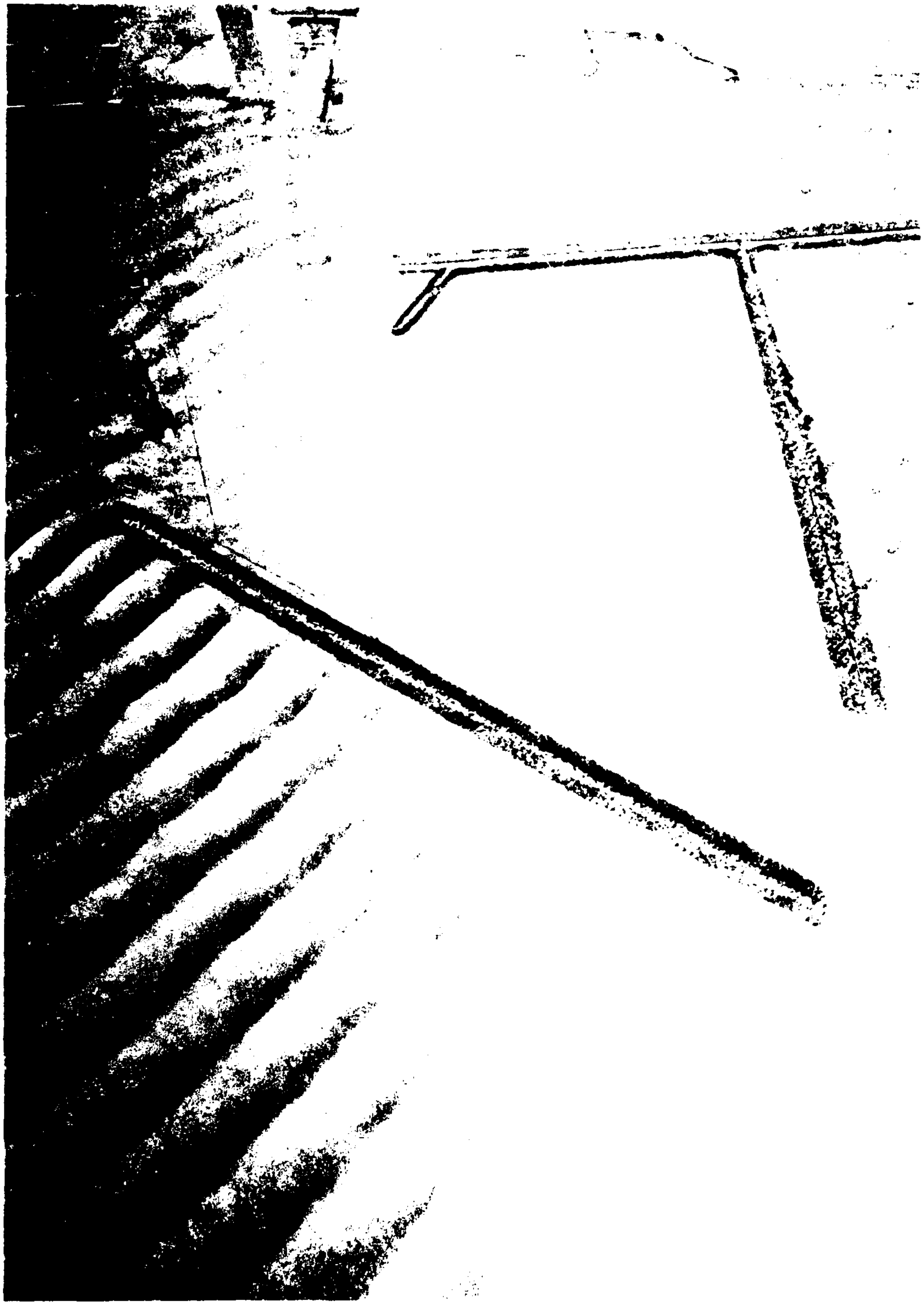


Photo 121. Typical wave patterns for Severe-Weather Plan 10A; 8-sec, 6.6-ft waves from 279 deg; +4.8 ft swl; river discharge 800 cfs

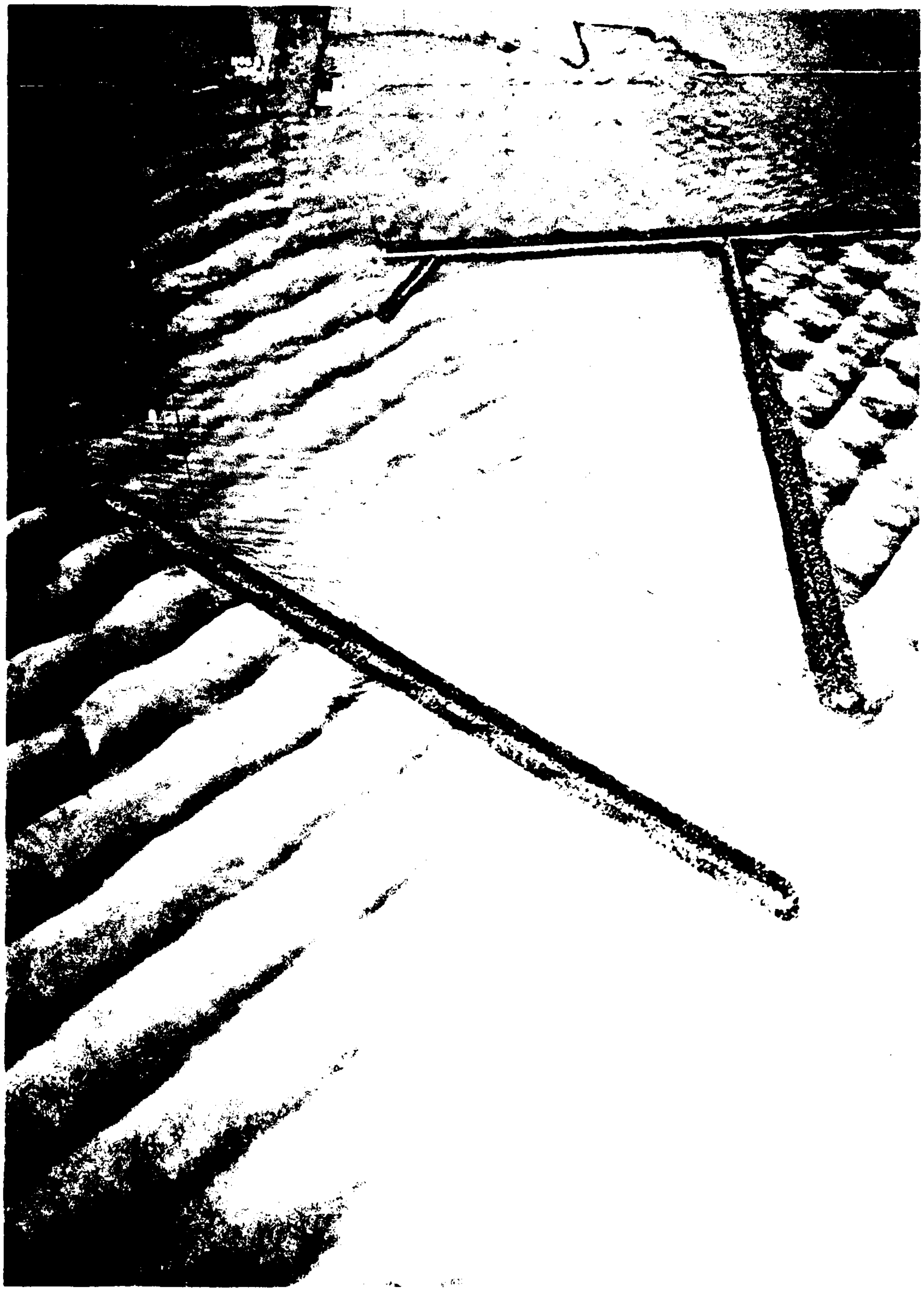


Photo 122. Typical wave patterns for Severe-Weather Plan 10A; 10-sec, 9.2-ft waves from 279 deg; +4.8 ft swl; river discharge 800 cfs

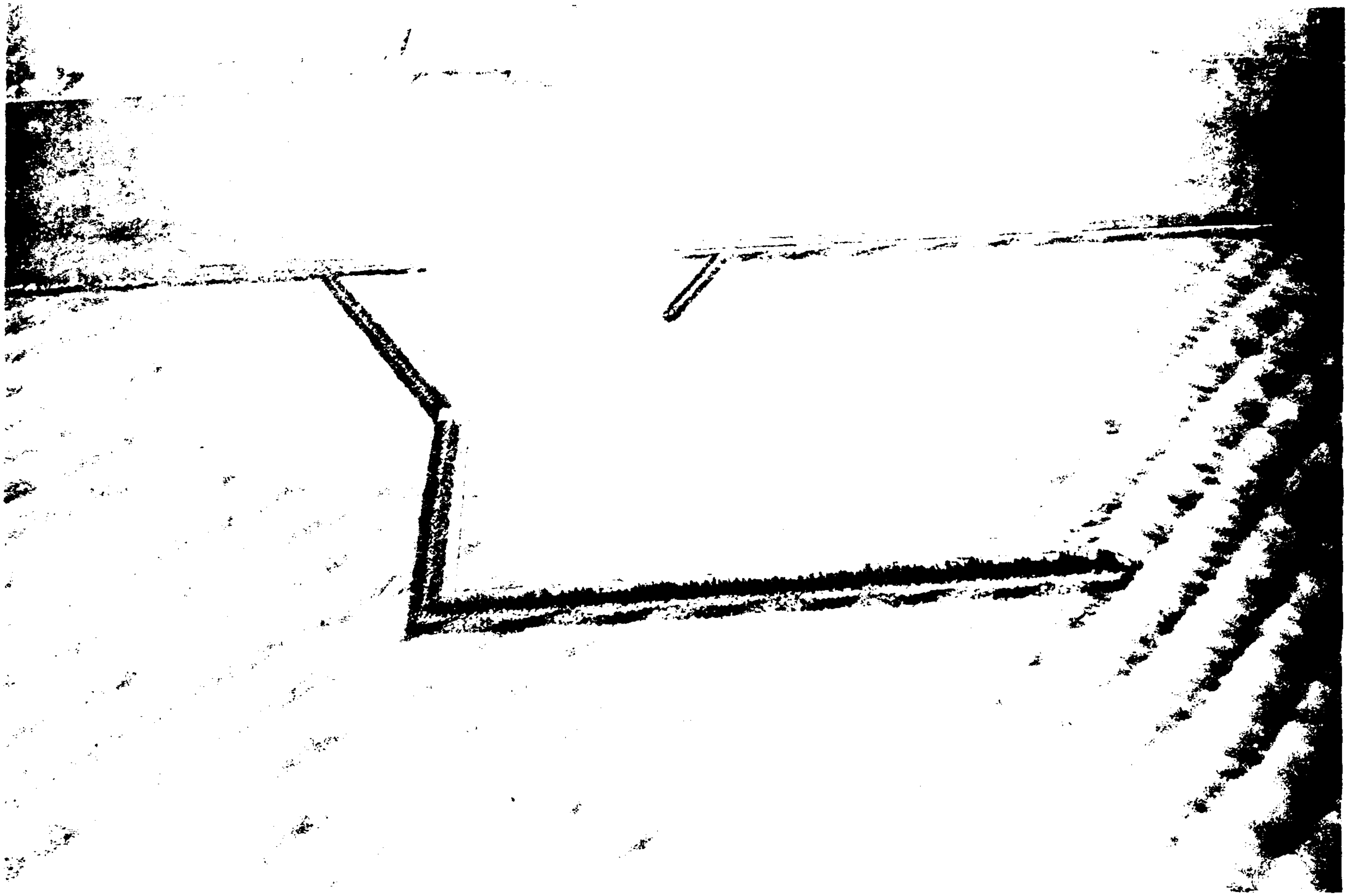


Photo 123. Typical wave patterns for Severe-Weather Plan 11; 8-sec, 6.6-ft waves from 279 deg; +4.8 ft swl; river discharge 800 cfs

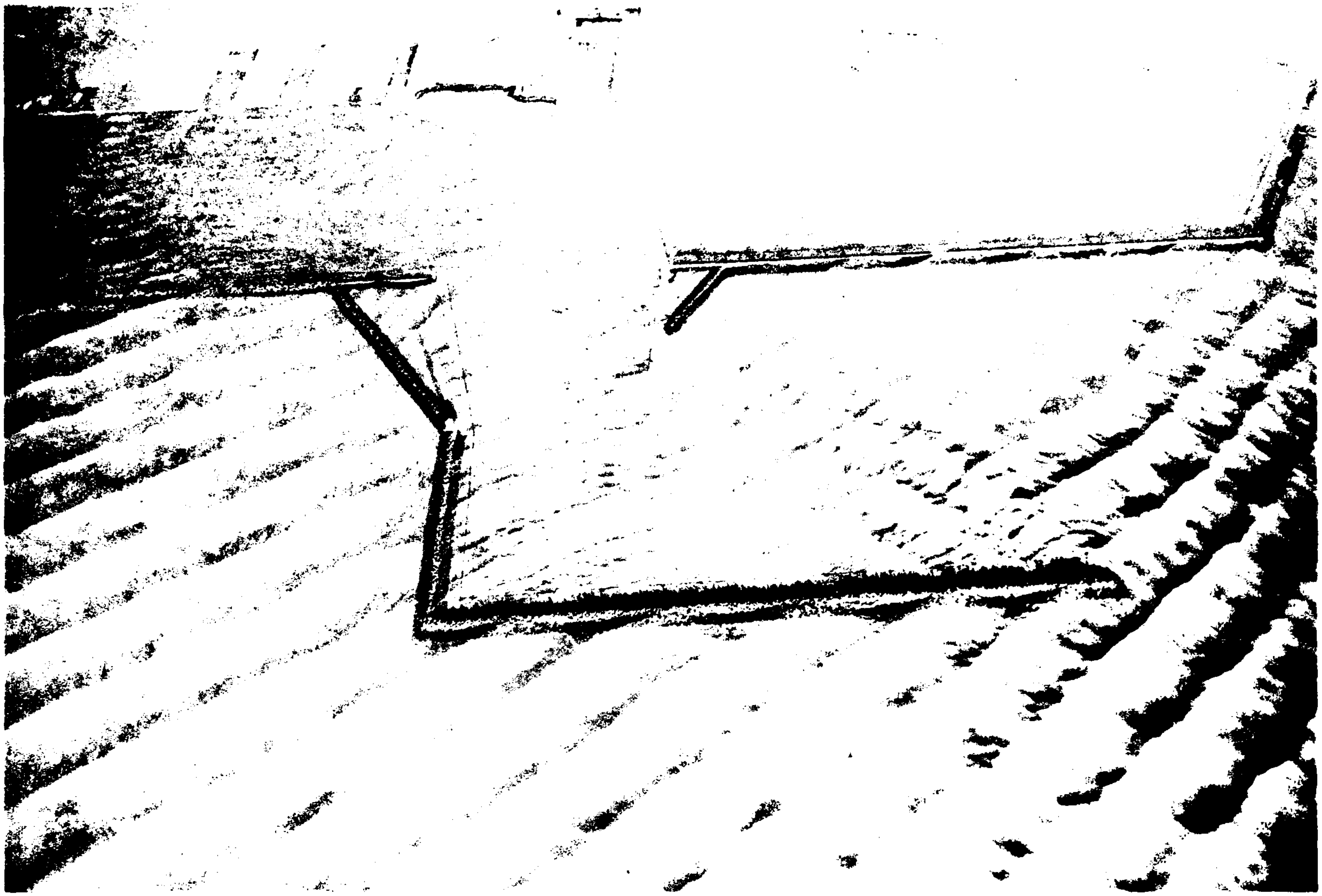


Photo 124. Typical wave patterns for Severe-Weather Plan 11; 10-sec, 9.2-ft waves from 279 deg; +4.8 ft swl; river discharge 800 cfs

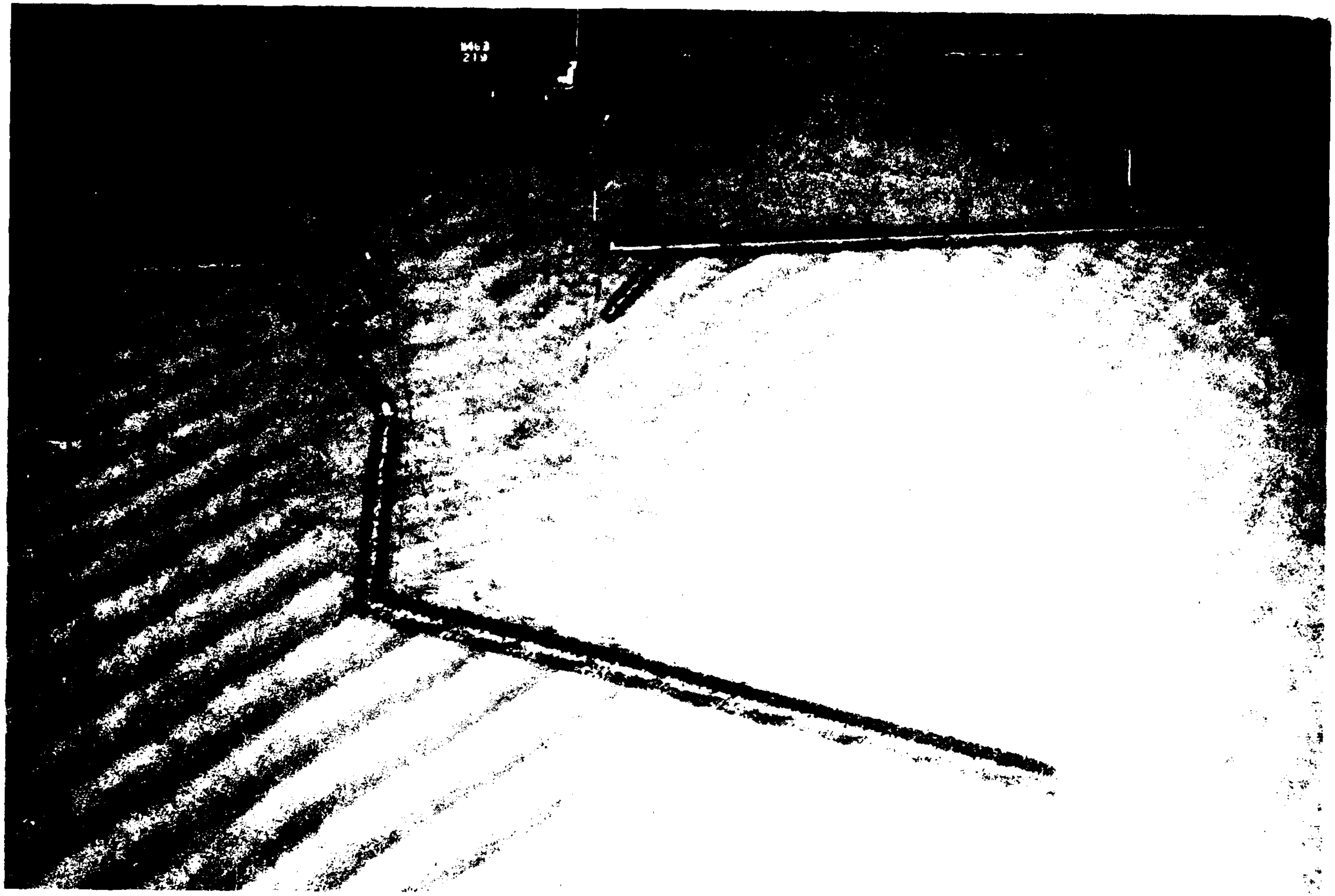


Photo 125. Typical wave patterns for Severe-Weather Plan 12; 8-sec, 6.6-ft waves from 279 deg; +4.8 ft swl; river discharge 800 cfs

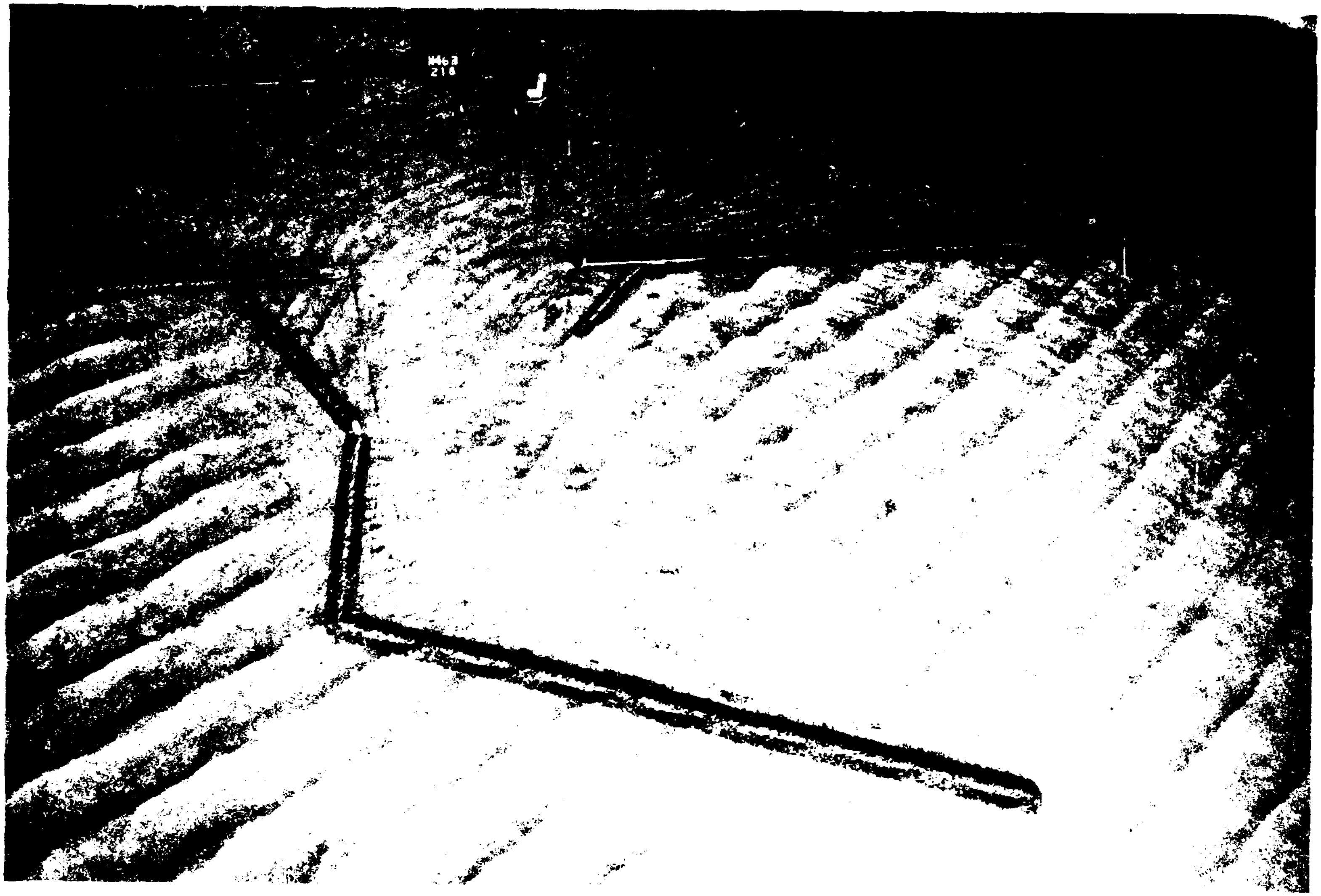


Photo 126. Typical wave patterns for Severe-Weather Plan 12; 10-sec, 9.2-ft waves from 279 deg; +4.8 ft swl; river discharge 800 cfs

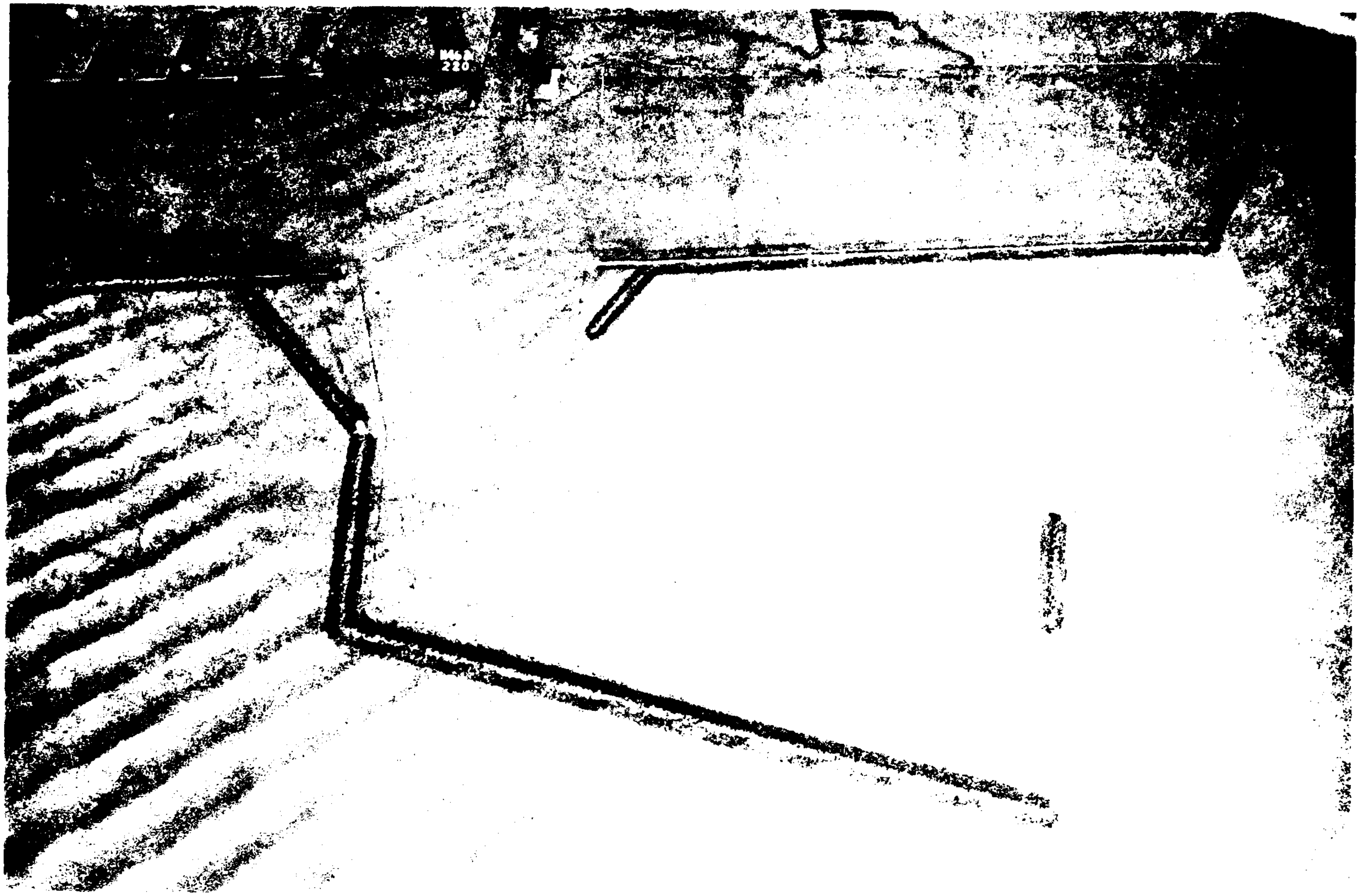


Photo 127. Typical wave patterns for Severe-Weather Plan 12A; 8-sec, 6.6-ft waves from 279 deg; +4.8 ft swl; river discharge 800 cfs

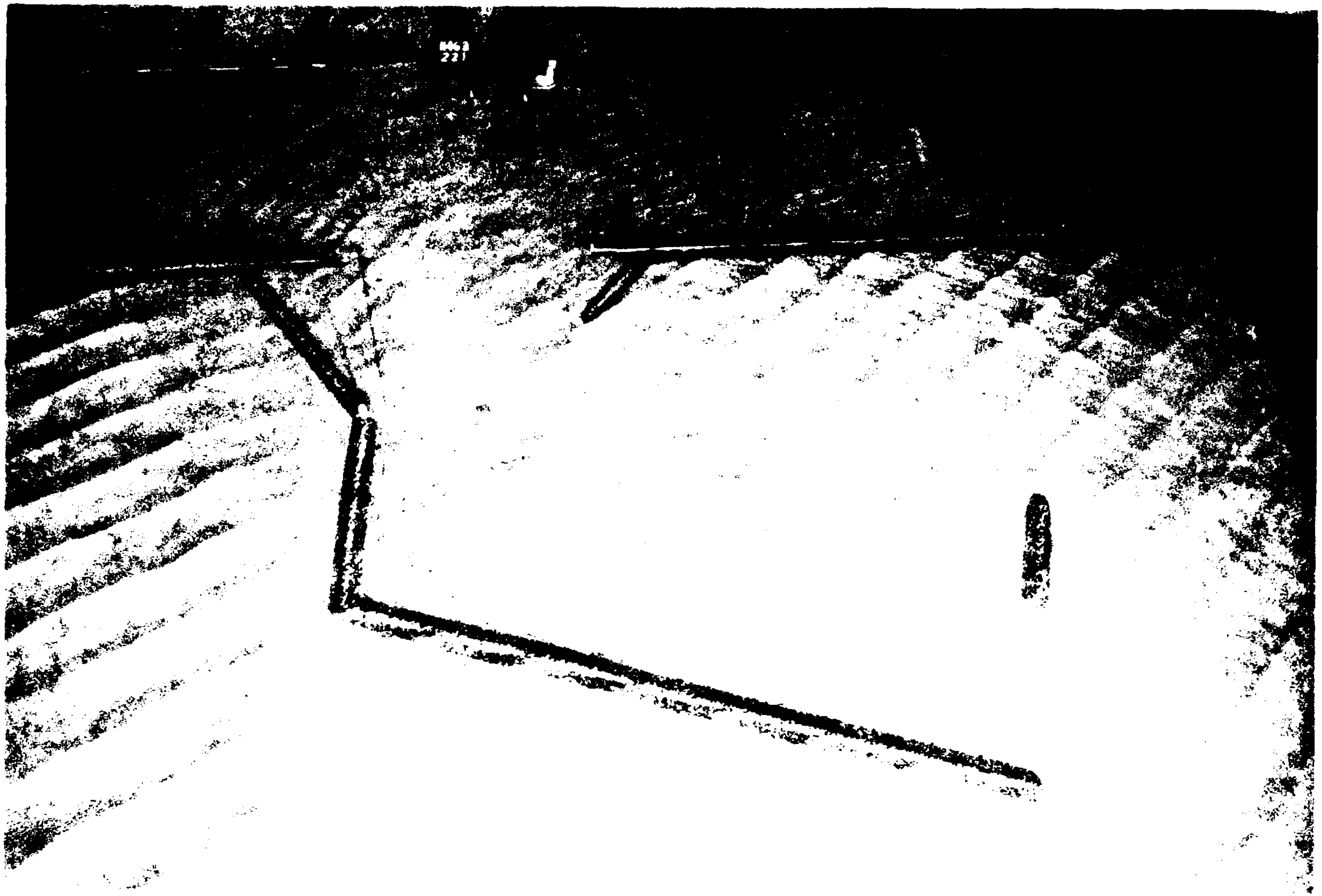


Photo 128. Typical wave patterns for Severe-Weather Plan 12A; 10-sec, 9.2-ft waves from 279 deg; +4.8 ft swl; river discharge 800 cfs

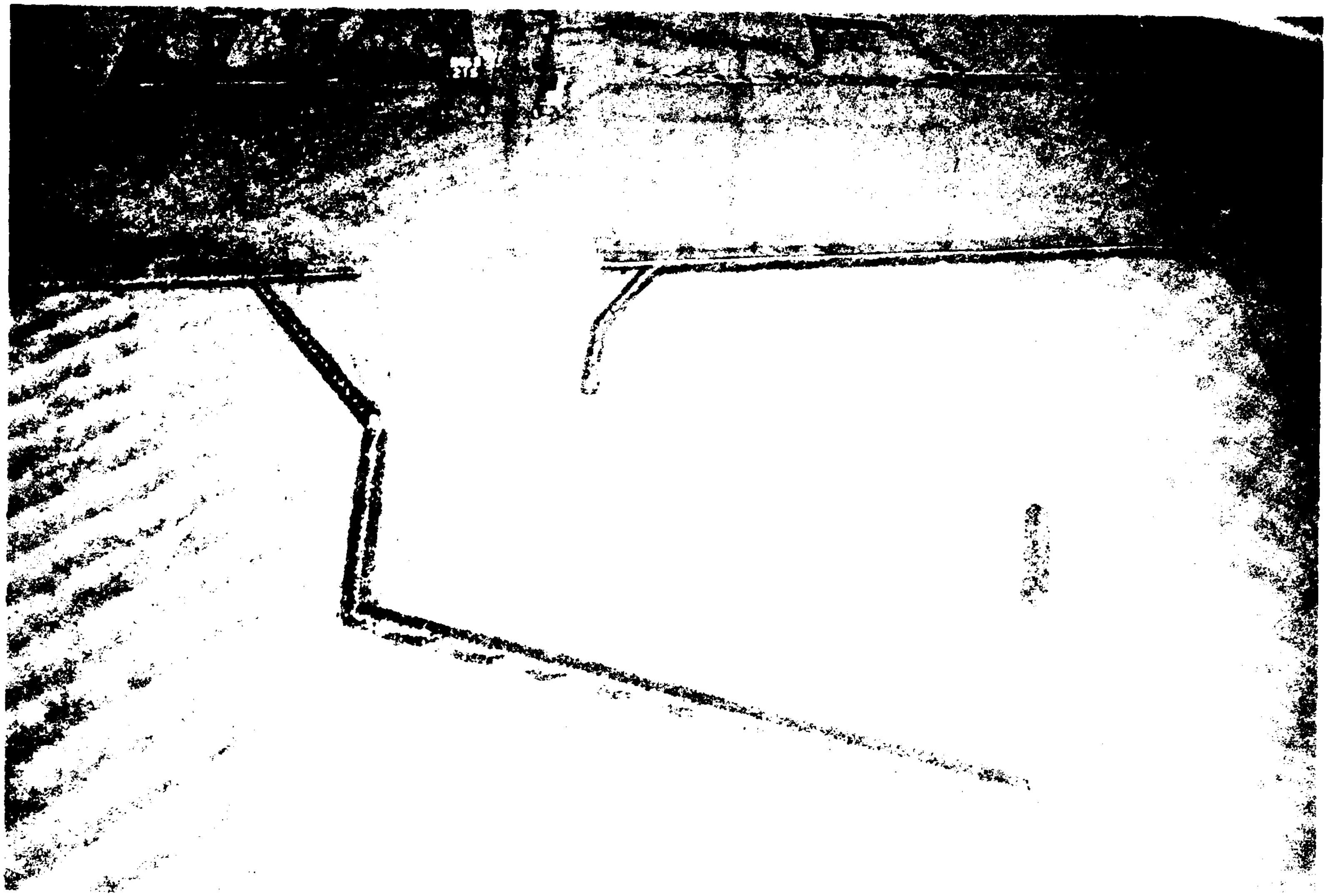


Photo 129. Typical wave patterns for Severe-Weather Plan 12B; 8-sec, 6.6-ft waves from 279 deg; +4.8 ft swl; river discharge 800 cfs

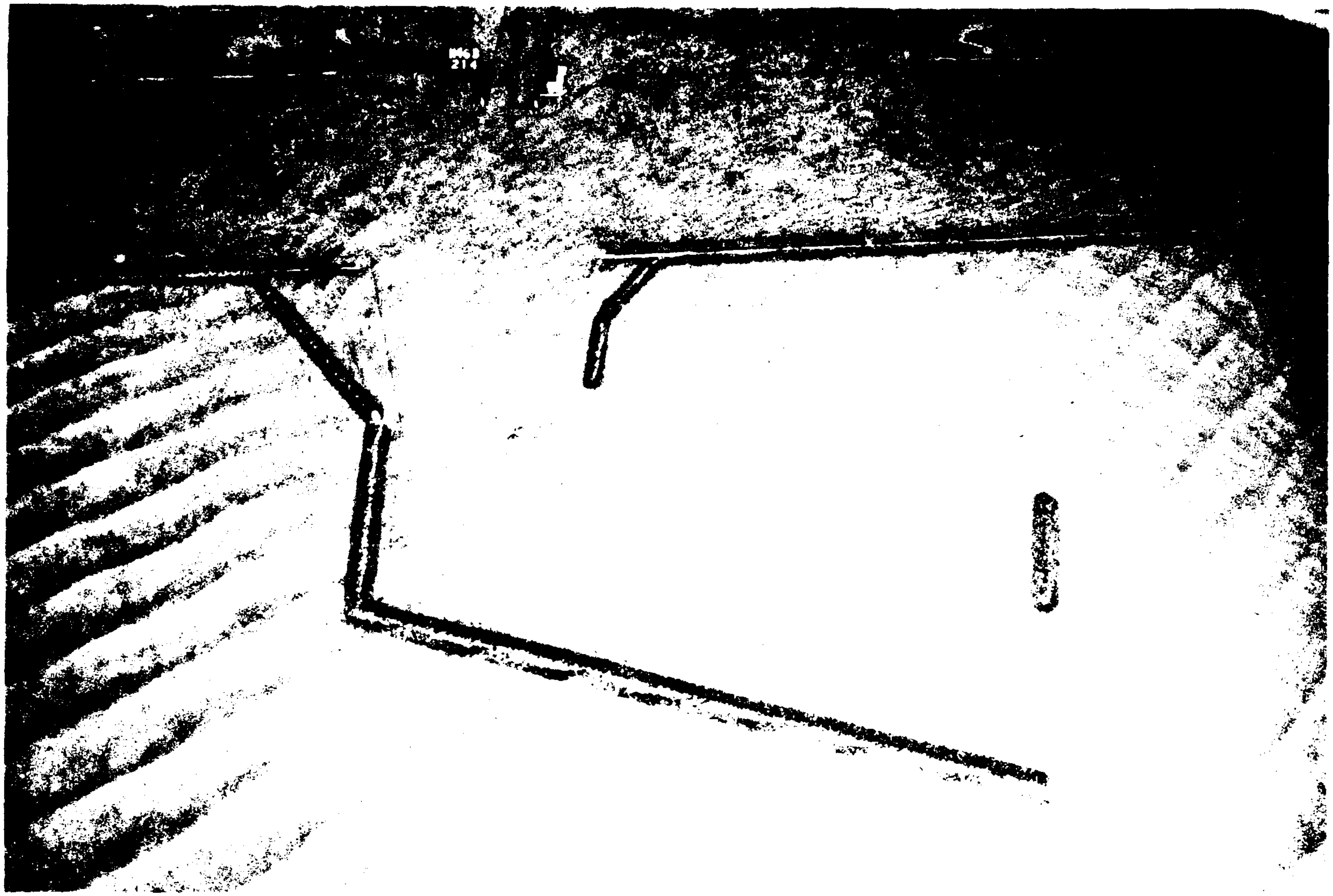


Photo 130. Typical wave patterns for Severe-Weather Plan 12B; 10-sec, 9.2-ft waves from 279 deg; +4.8 ft swl; river discharge 800 cfs

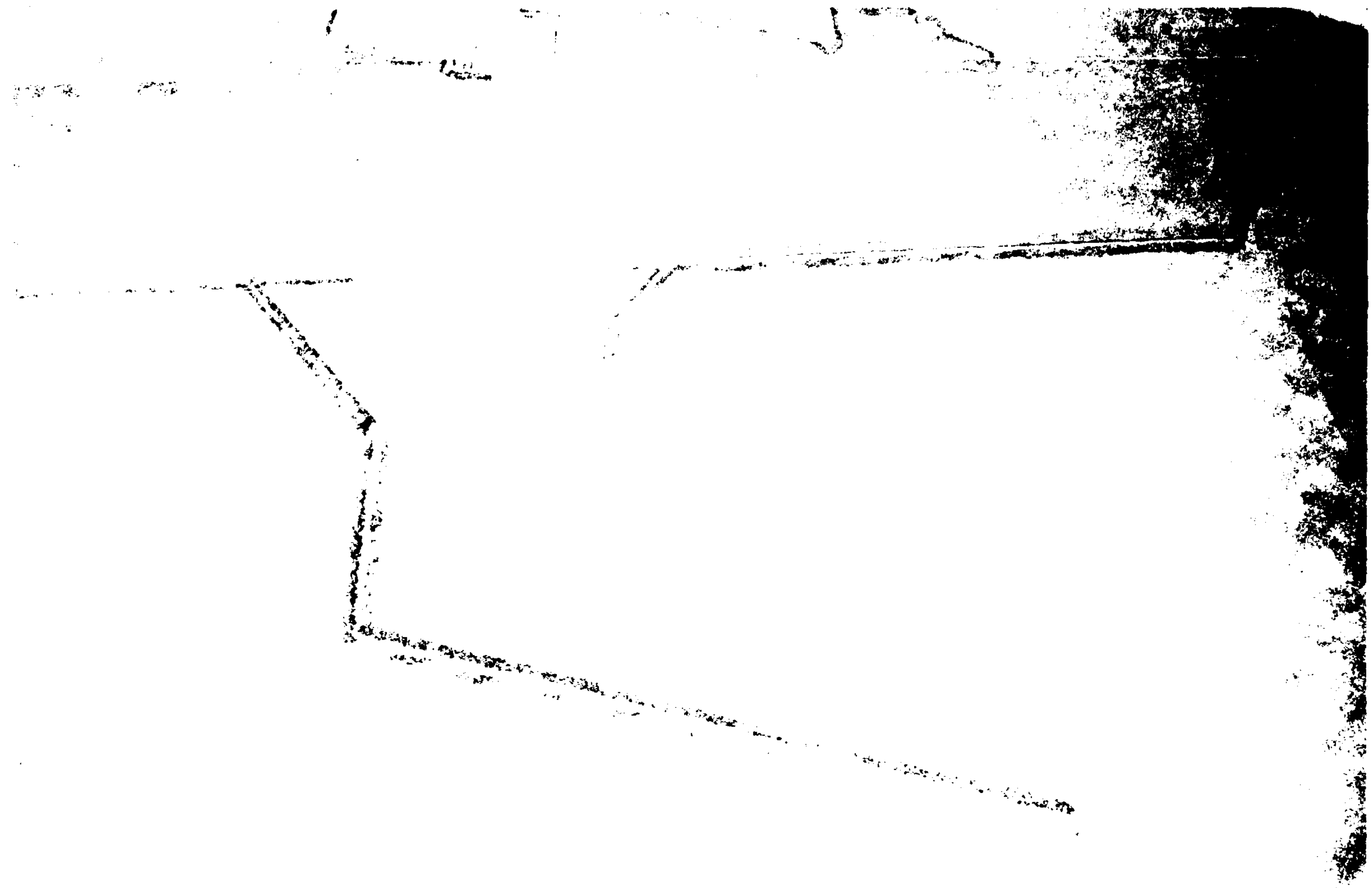


Photo 131. Typical wave patterns for Severe-Weather Plan 12C; 8-sec, 6.6-ft waves from 279 deg; +4.8 ft swl; river discharge 800 cfs

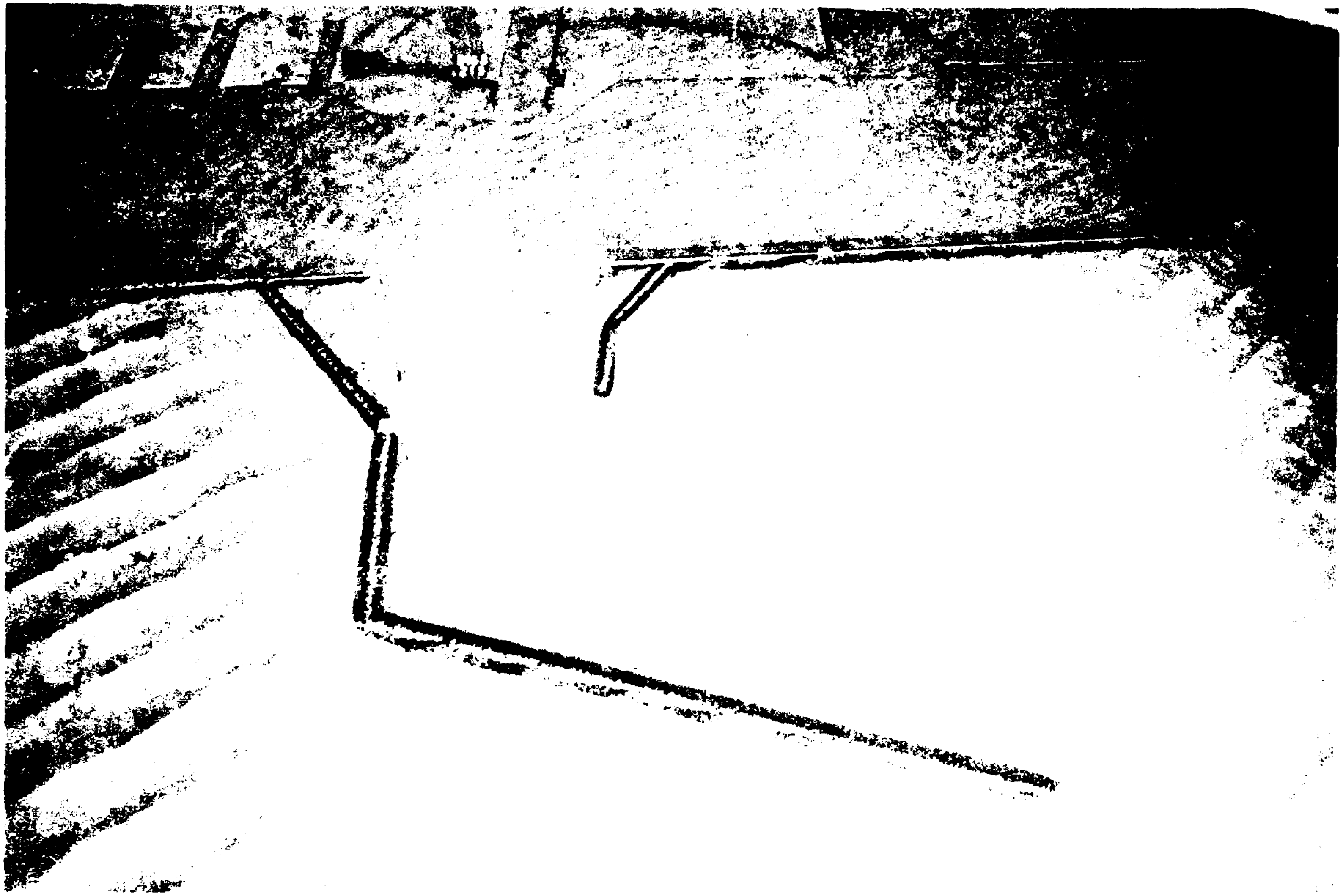


Photo 132. Typical wave patterns for Severe-Weather Plan 12C; 10-sec, 9.2-ft waves from 279 deg; +4.8 ft swl; river discharge 800 cfs

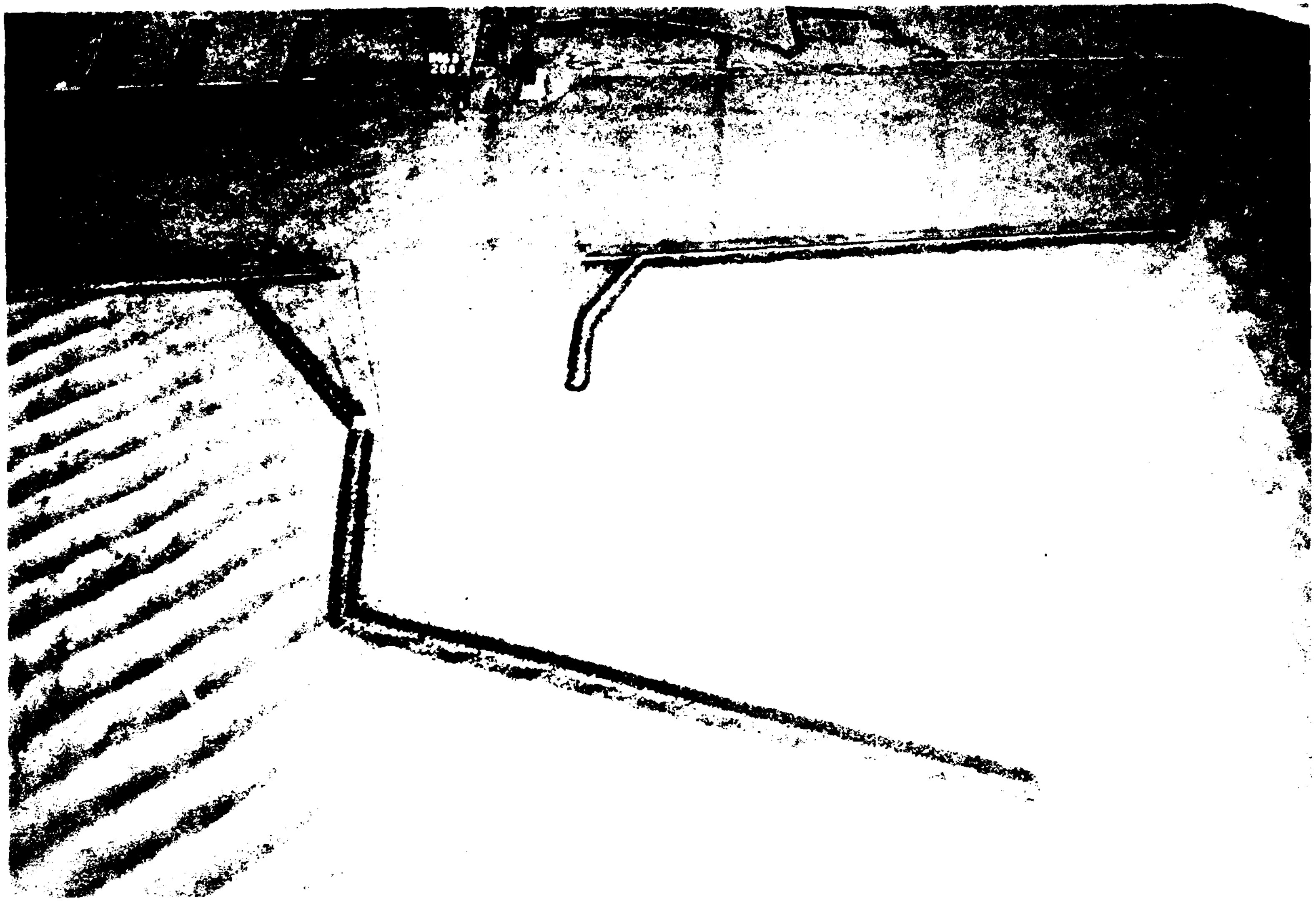


Photo 133. Typical wave patterns for Severe-Weather Plan 12D; 8-sec, 6.6-ft waves from 279 deg; +4.8 ft swl; river discharge 800 cfs

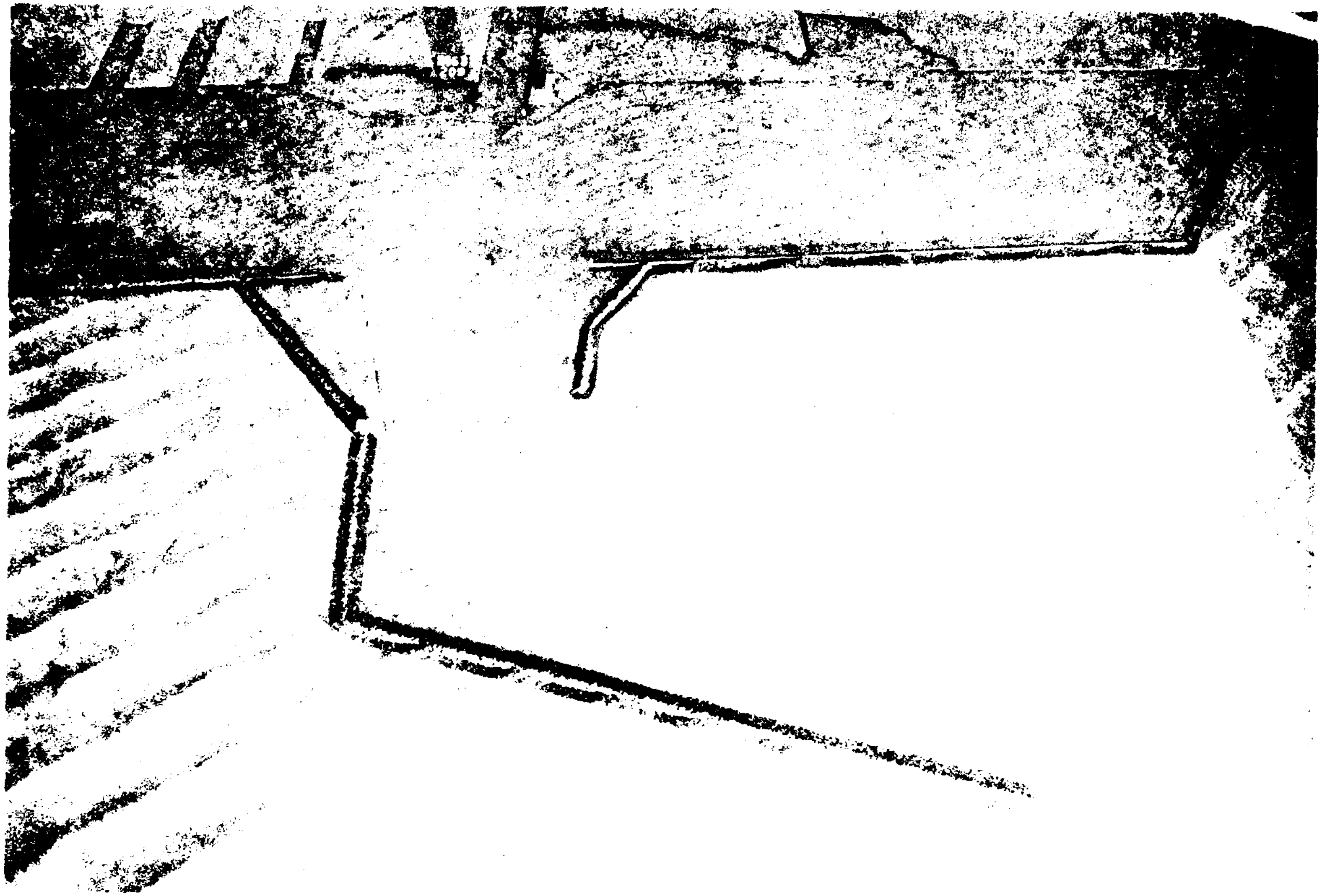


Photo 134. Typical wave patterns for Severe-Weather Plan 12D; 10-sec, 9.2-ft waves from 279 deg; +4.8 ft swl; river discharge 800 cfs

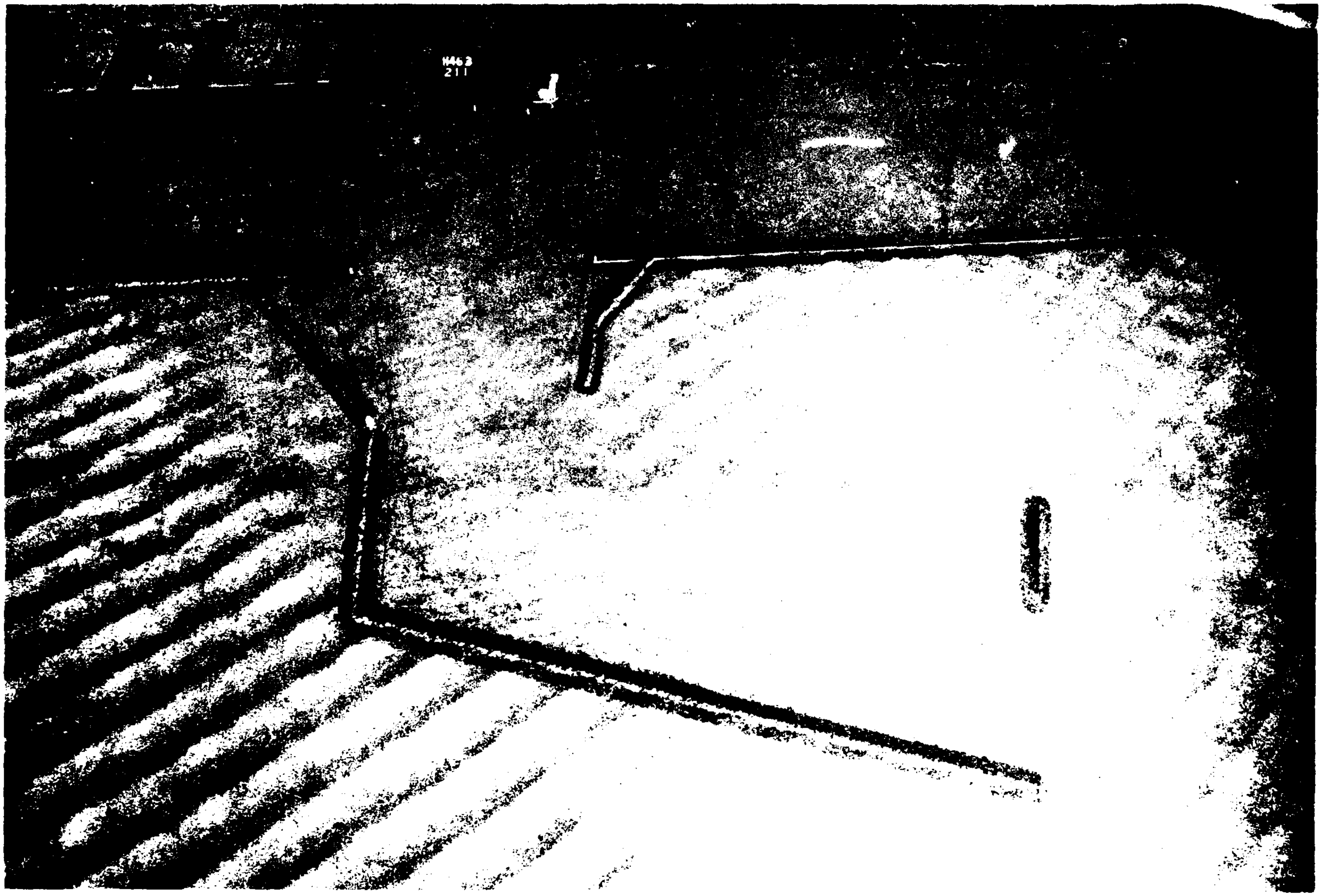


Photo 135. Typical wave patterns for Severe-Weather Plan 12E; 8-sec, 6.6-ft waves from 279 deg; +4.8 ft swl; river discharge 800 cfs

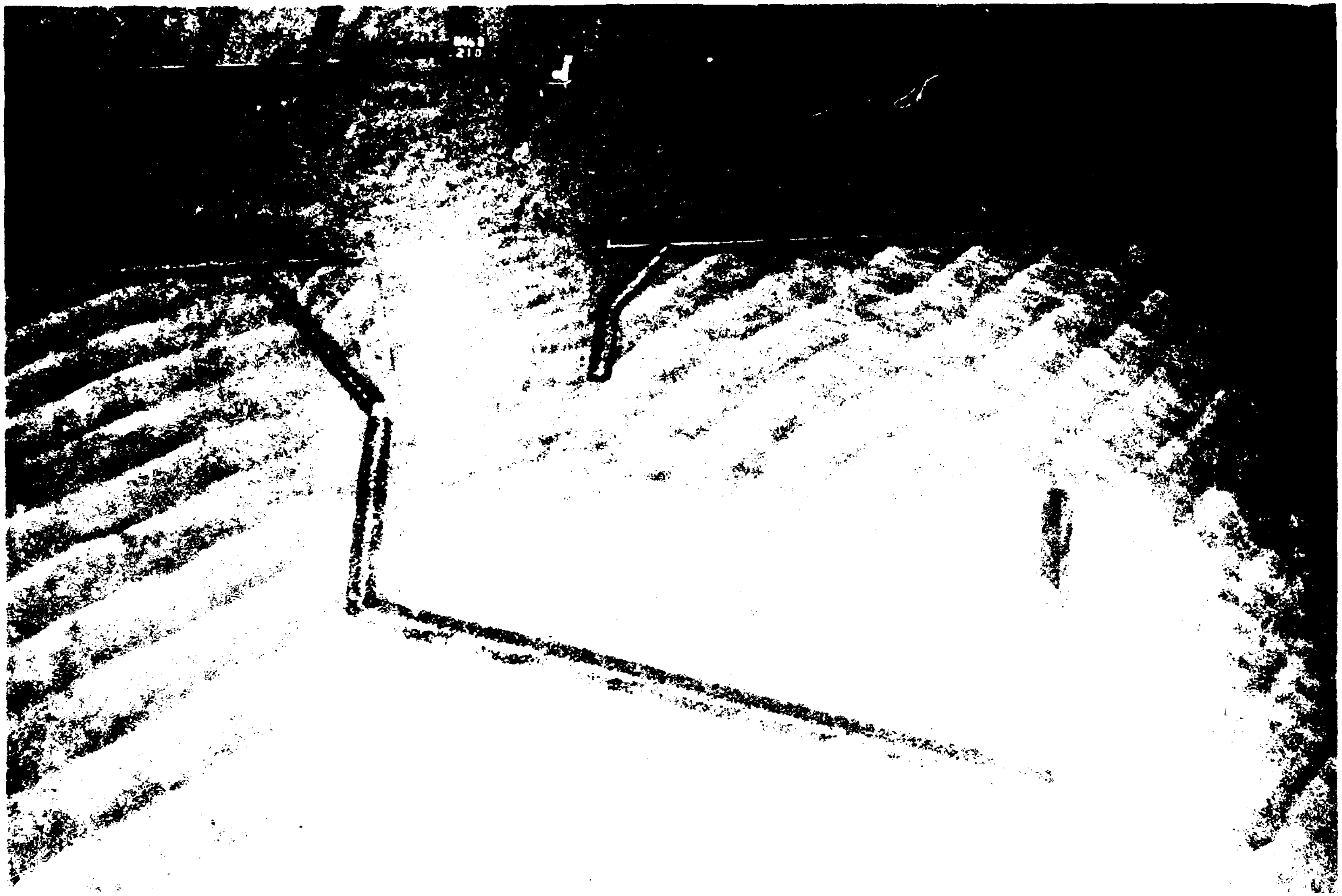


Photo 136. Typical wave patterns for Severe-Weather Plan 12E; 10-sec, 9.2-ft waves from 279 deg; +4.8 ft swl; river discharge 800 cfs

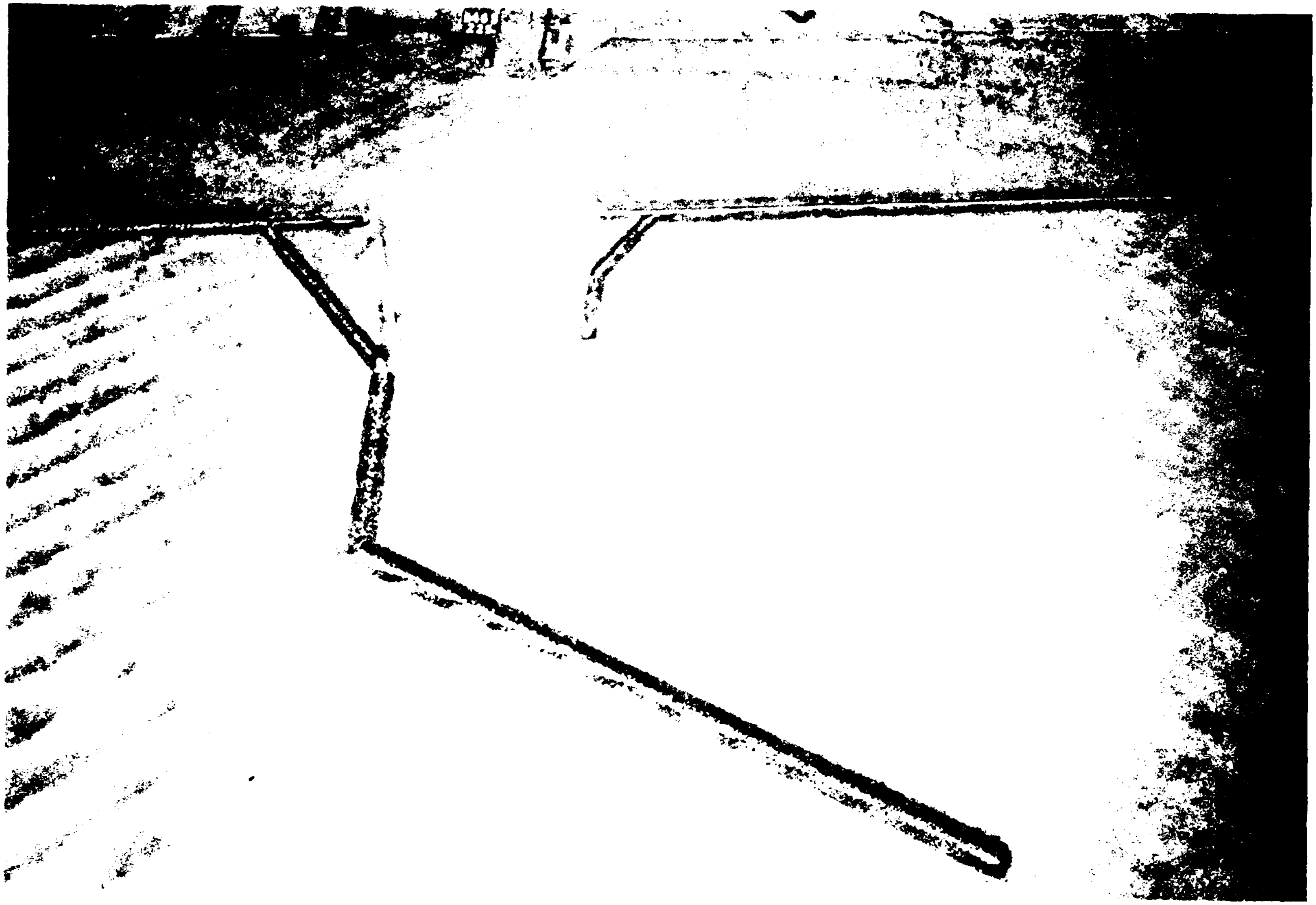


Photo 137. Typical wave patterns for Severe-Weather Plan 13; 8-sec, 6.6-ft waves from 279 deg; +4.8 ft swl; river discharge 800 cfs

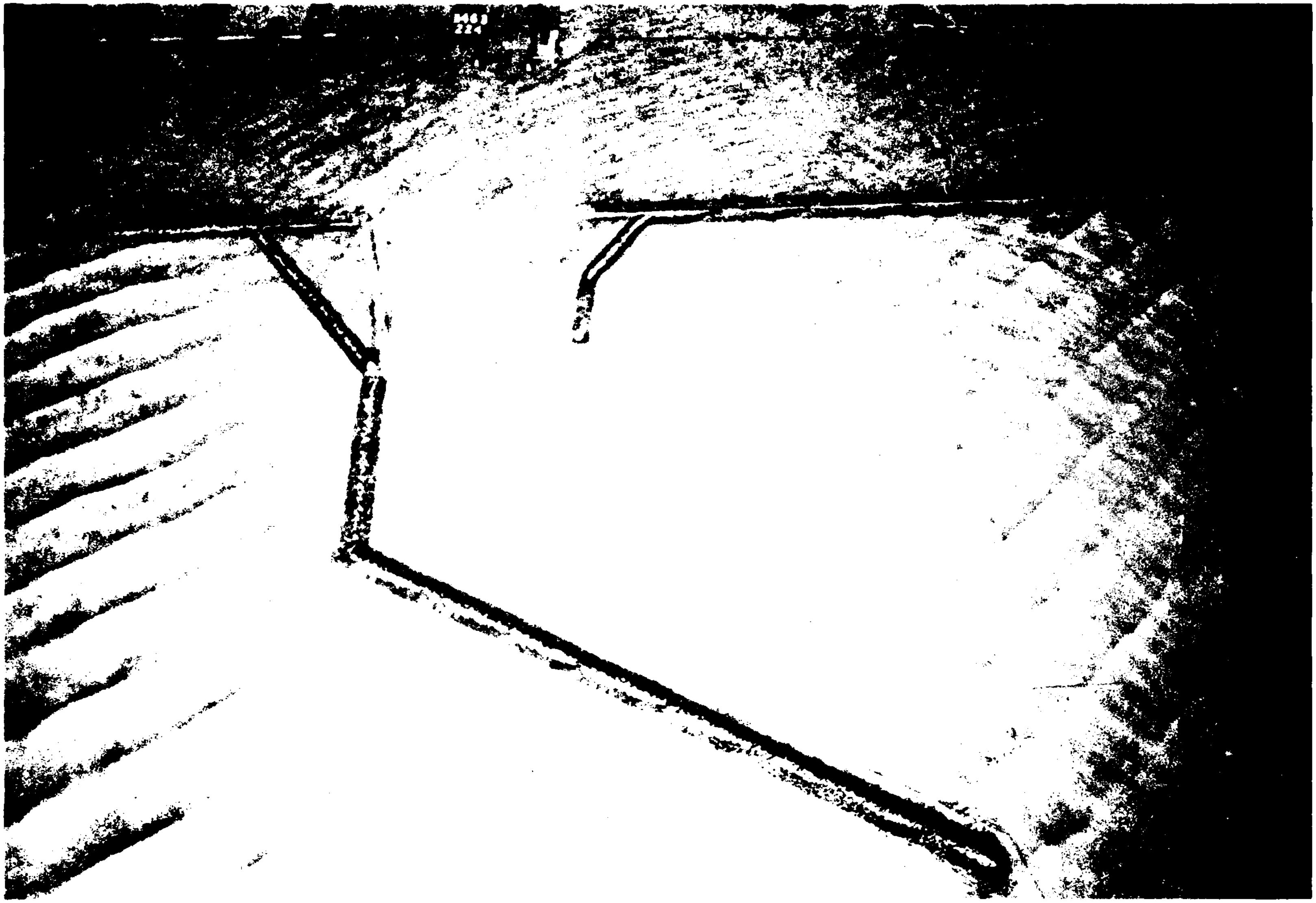


Photo 138. Typical wave patterns for Severe-Weather Plan 13; 10-sec, 9.2-ft waves from 279 deg; +4.8 ft swl; river discharge 800 cfs

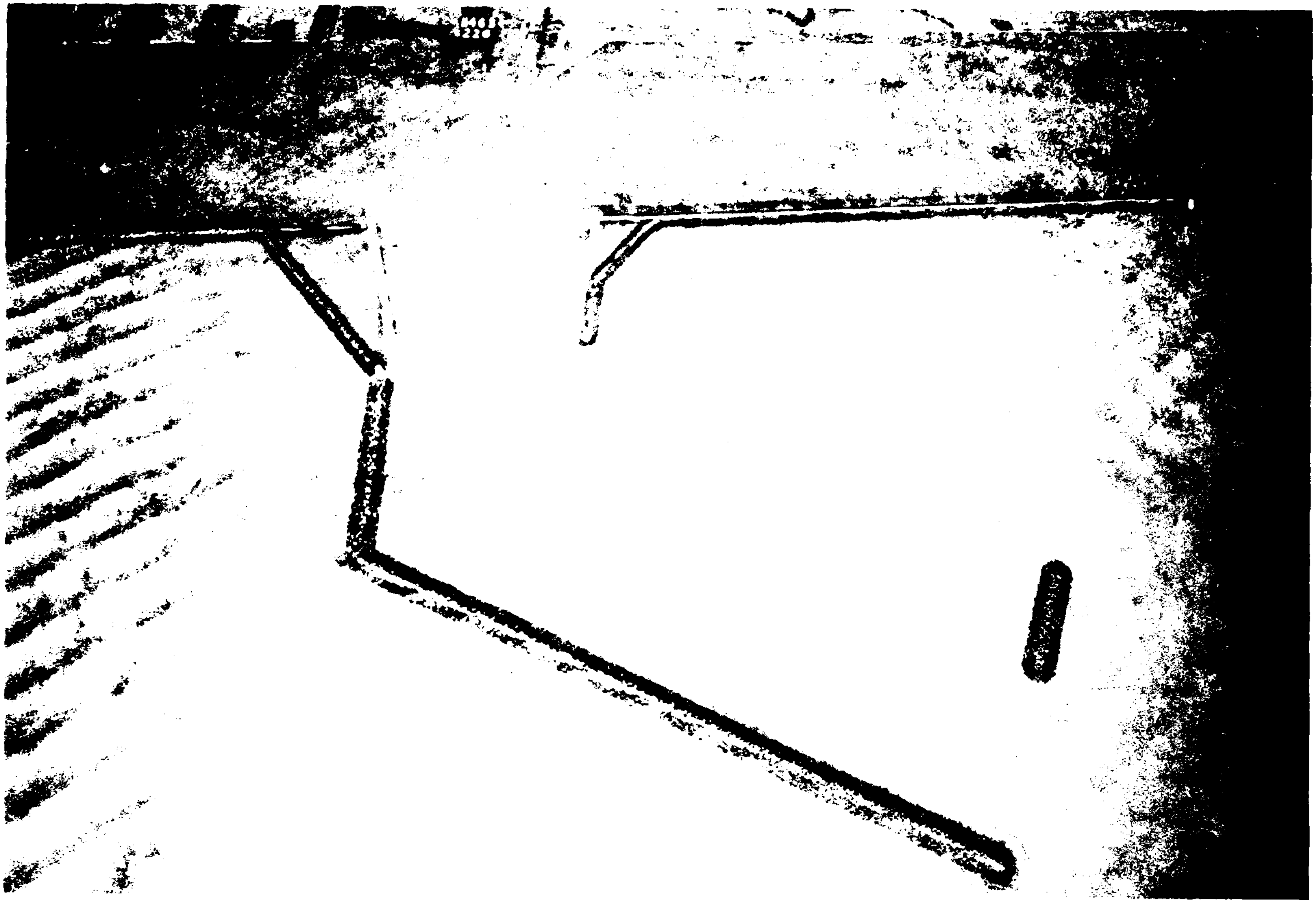


Photo 139. Typical wave patterns for Severe-Weather Plan 13A; 8-sec, 6.6-ft waves from 279 deg; +4.8 ft swl; river discharge 800 cfs

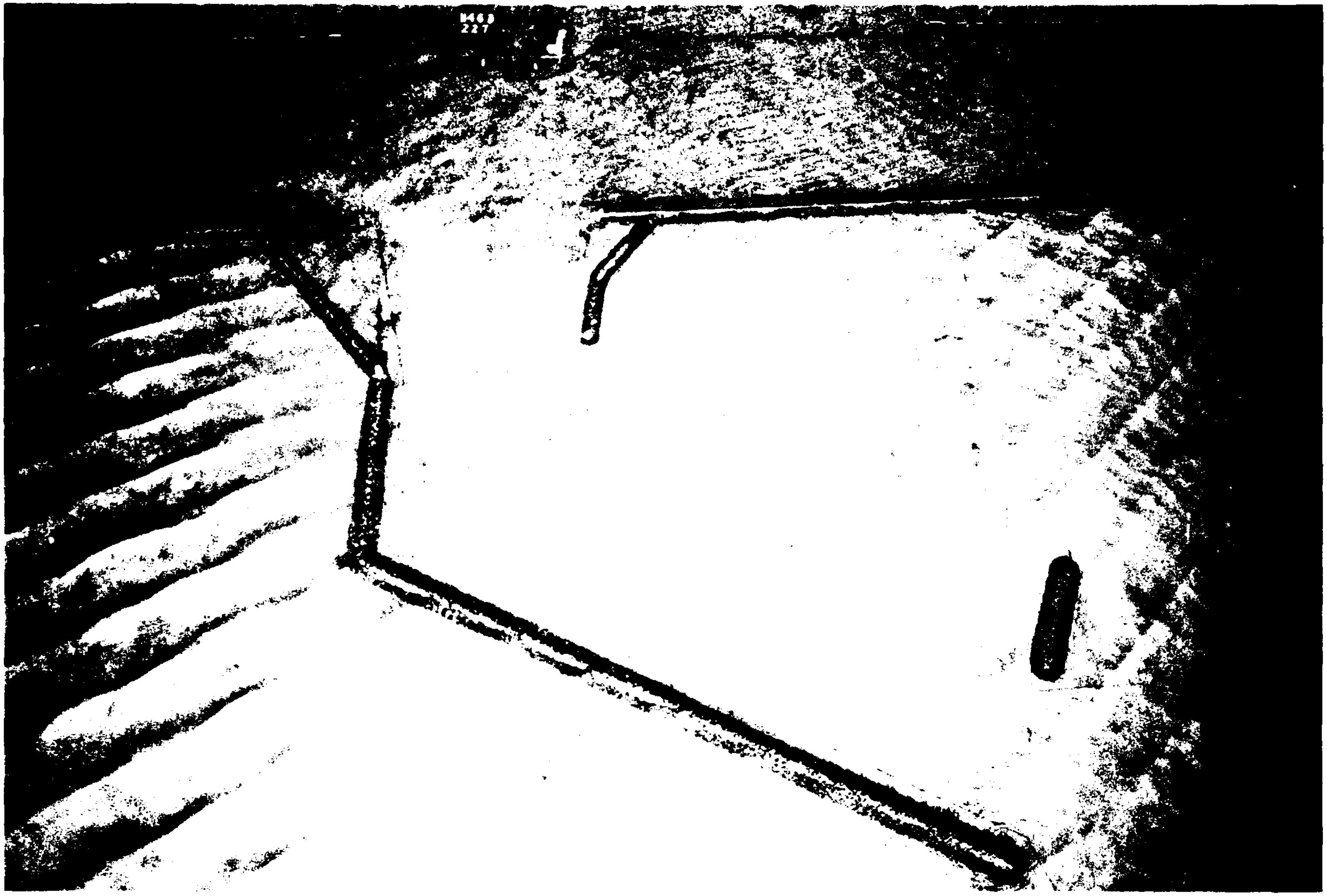


Photo 140. Typical wave patterns for Severe-Weather Plan 13A; 10-sec, 9.2-ft waves from 279 deg; +4.8 ft swl; river discharge 800 cfs

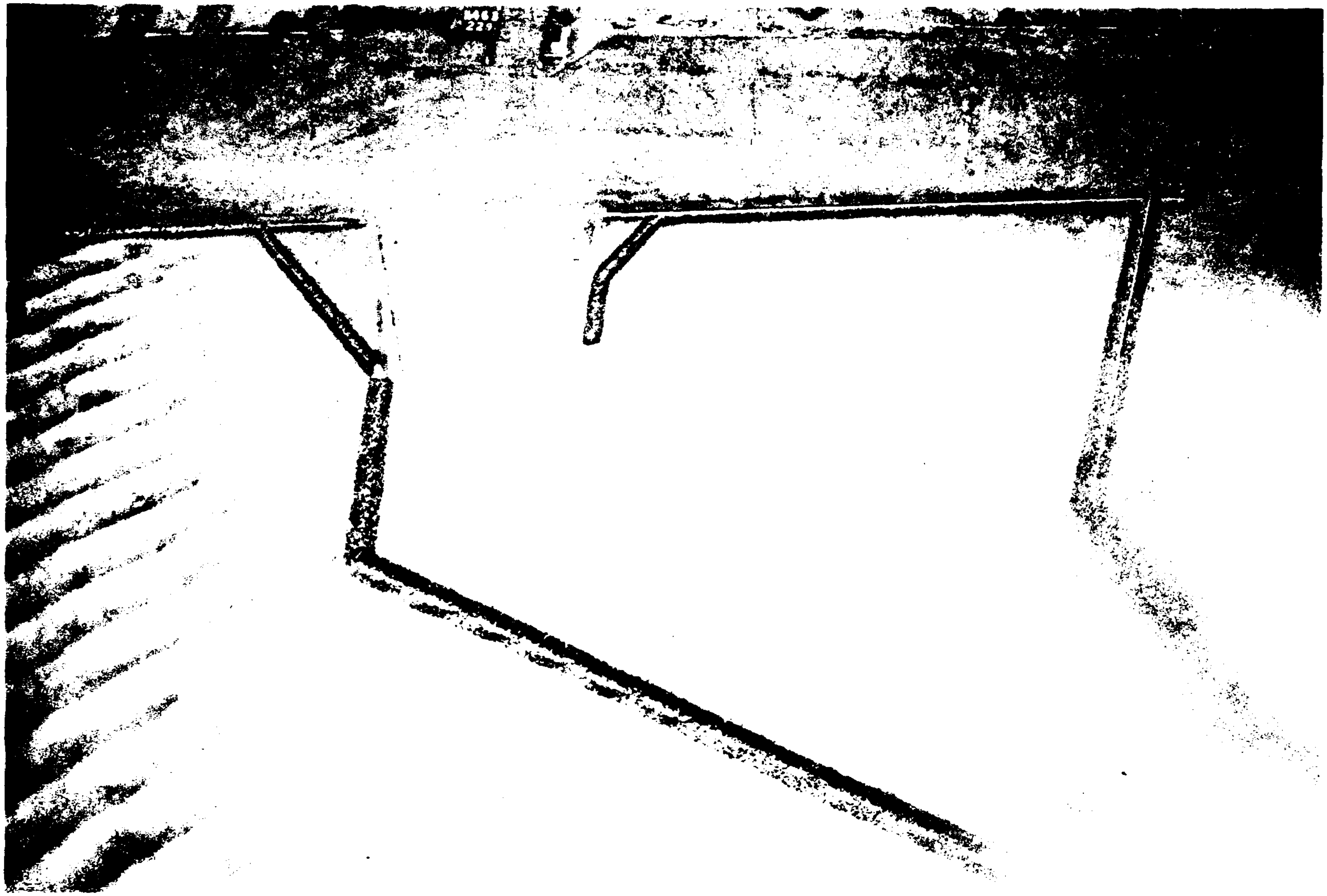


Photo 141. Typical wave patterns for Severe-Weather Plan 13B; 8-sec, 6.6-ft waves from 279 deg; +4.8 ft swl; river discharge 800 cfs

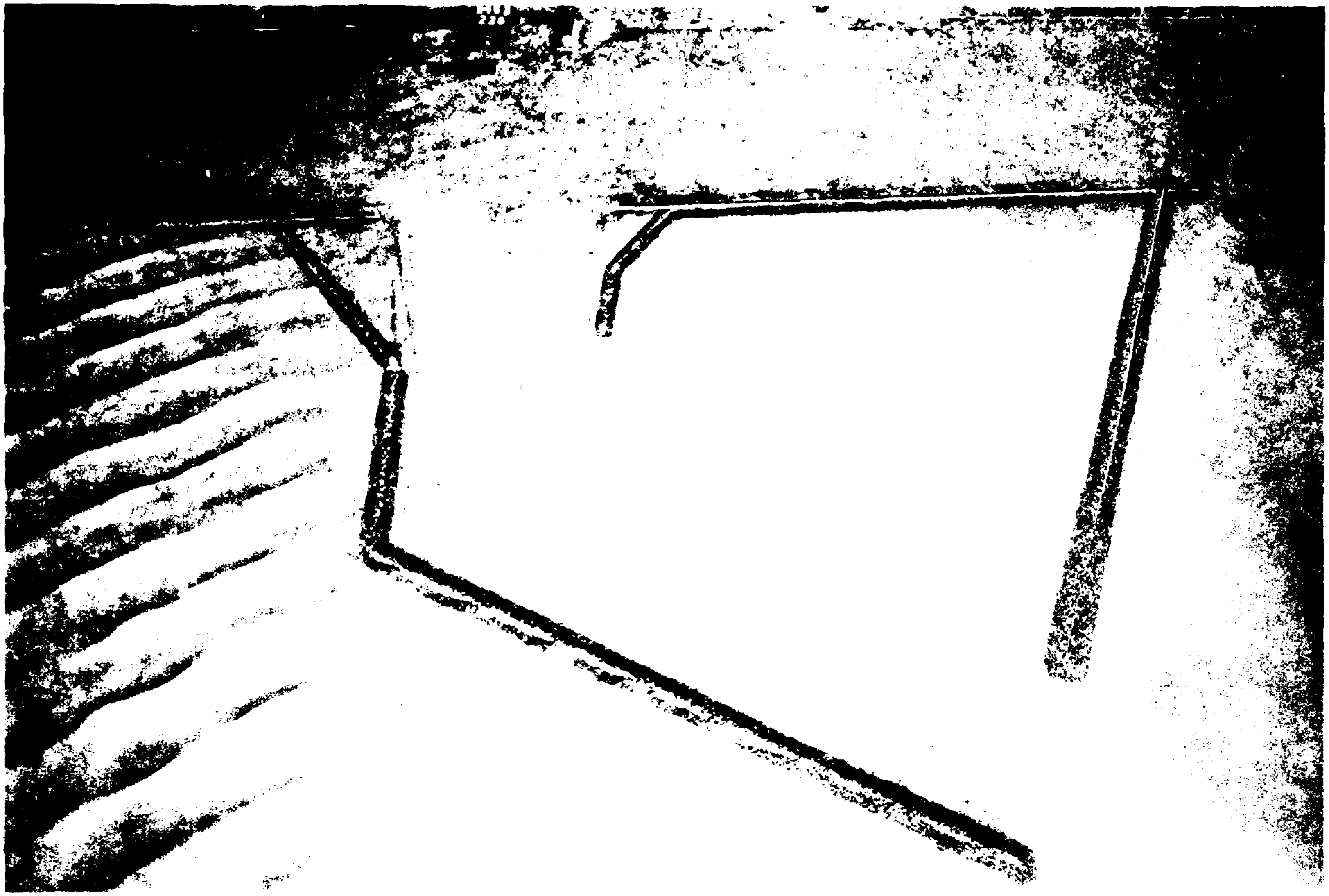


Photo 142. Typical wave patterns for Severe-Weather Plan 13B; 10-sec, 9.2-ft waves from 279 deg; +4.8 ft swl; river discharge 800 cfs

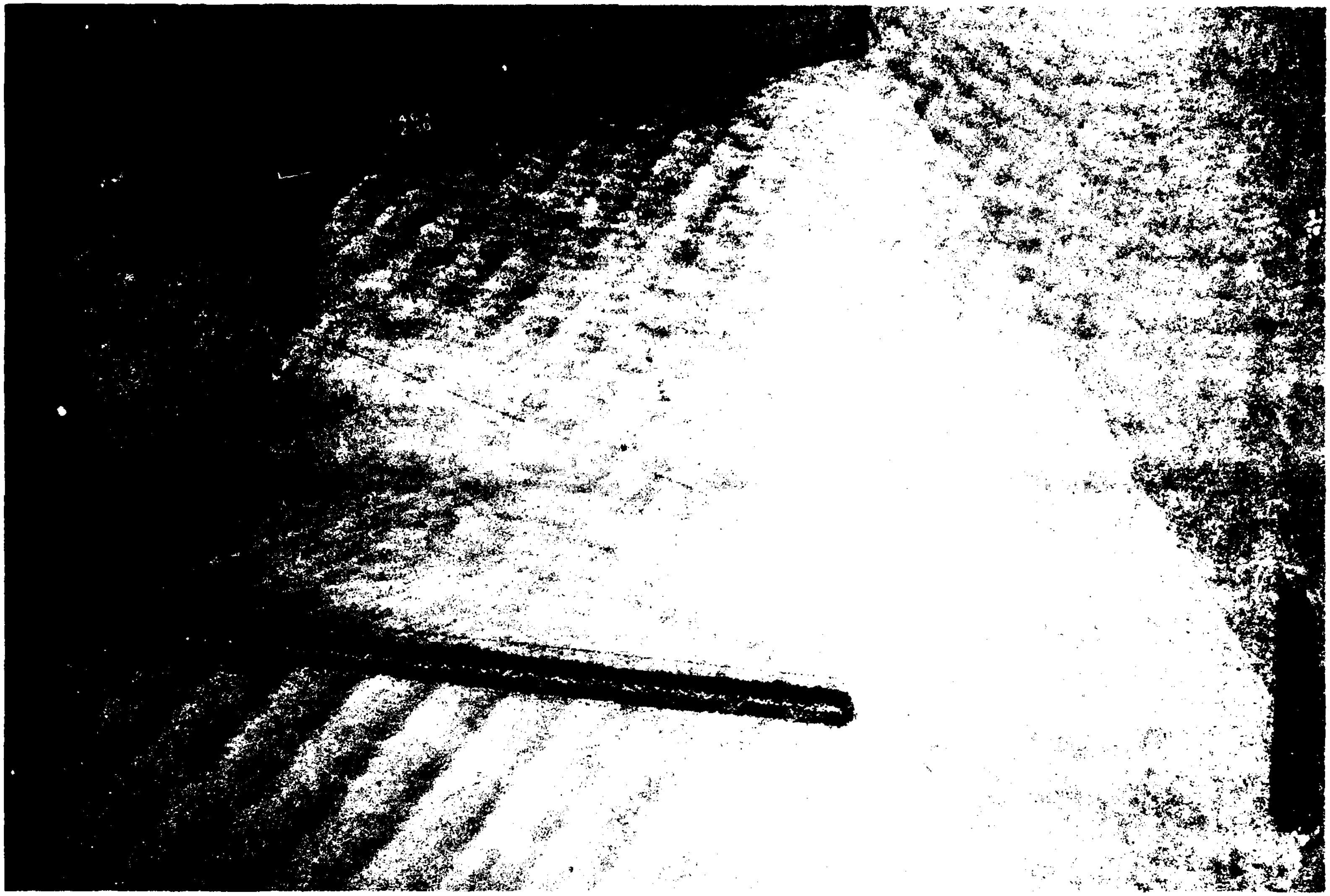


Photo 143. Typical wave patterns for Severe-Weather Plan 13C; 8-sec, 6.6-ft waves from 279 deg; +4.8 ft swl; river discharge 800 cfs

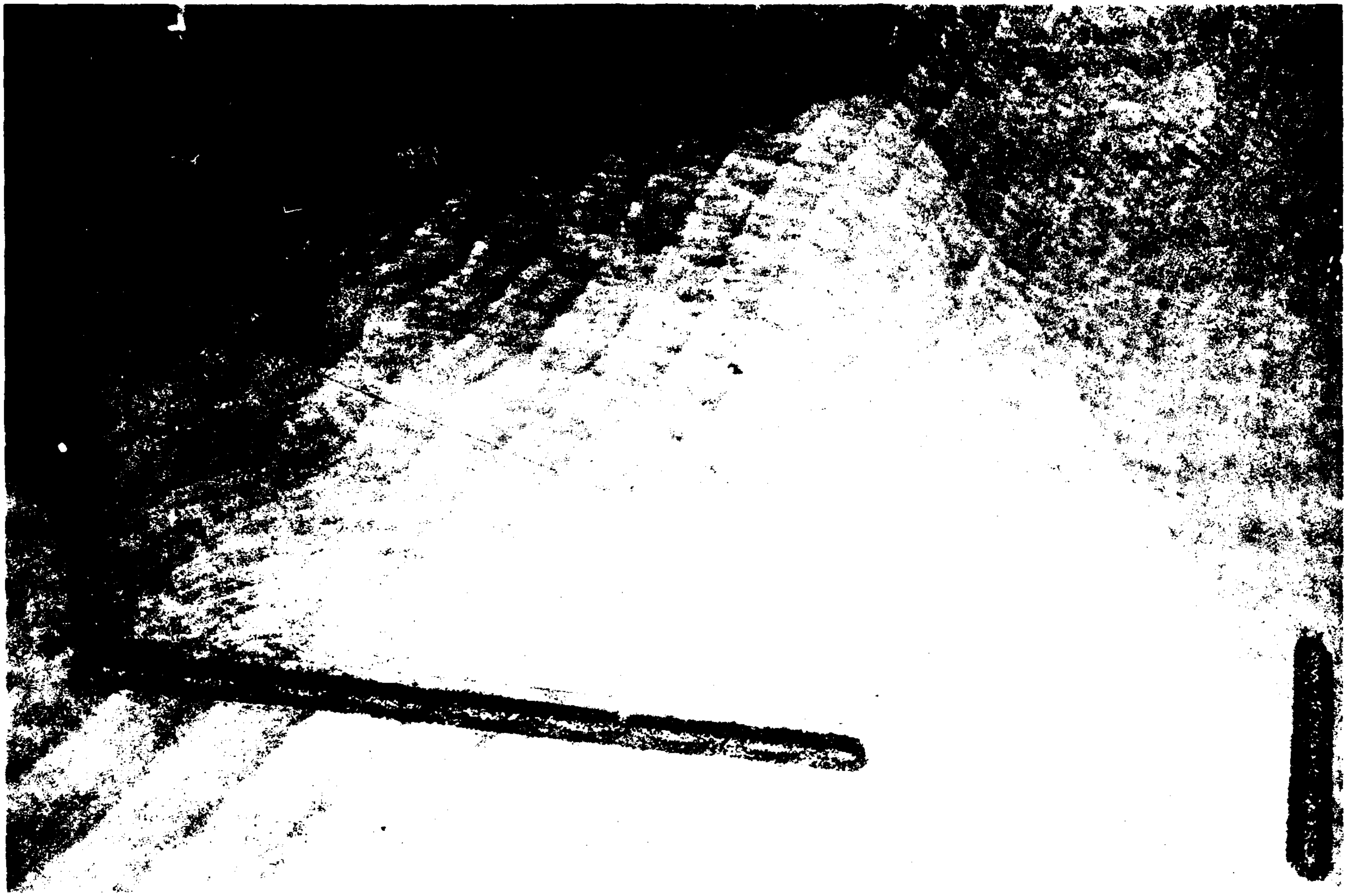


Photo 144. Typical wave patterns for Severe-Weather Plan 13C; 10-sec, 9.2-ft waves from 279 deg; +4.8 ft swl; river discharge 800 cfs

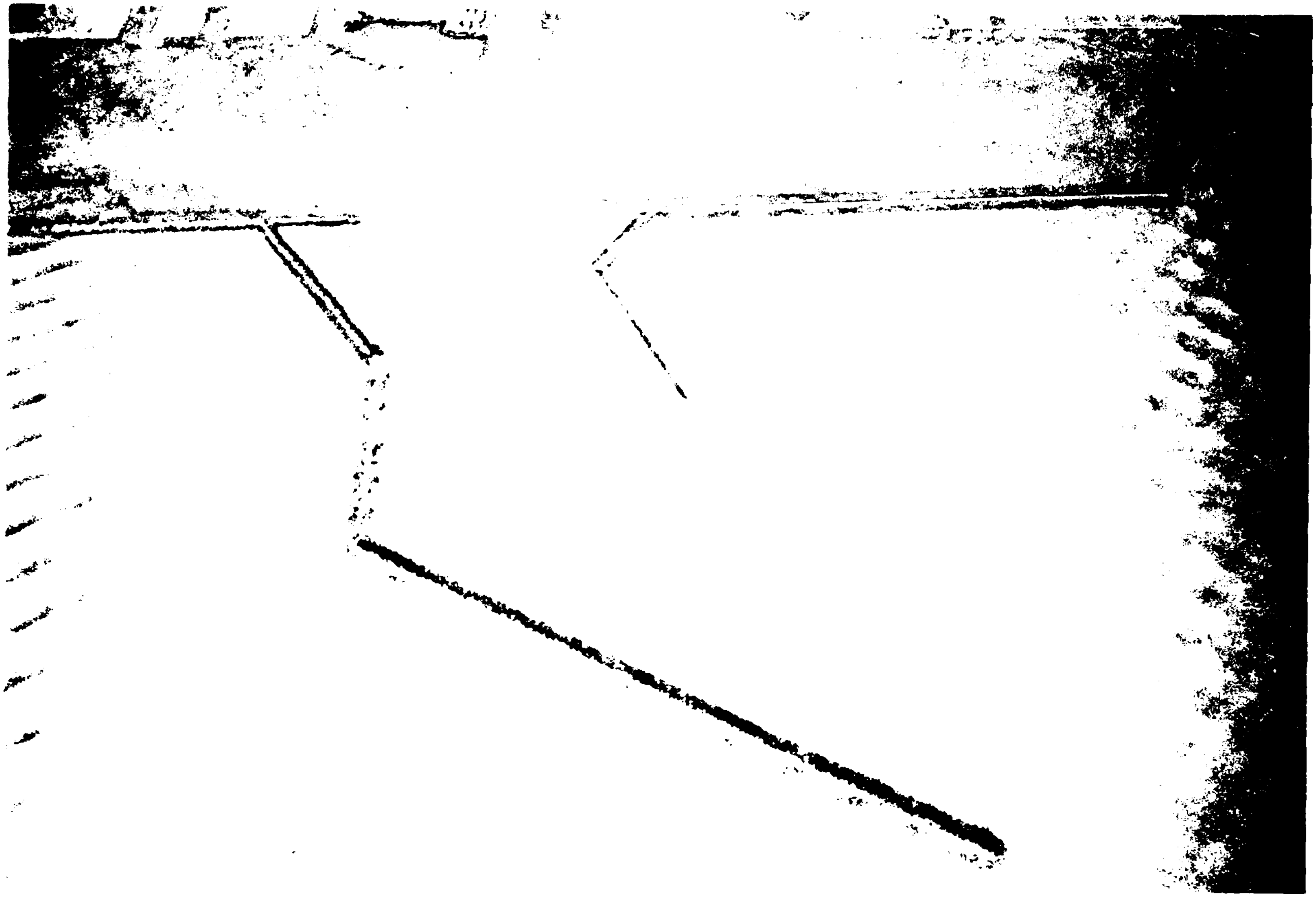


Photo 145. Typical wave patterns for Severe-Weather Plan 13D; 8-sec, 6.6-ft waves from 279 deg; +4.8 ft swl; river discharge 800 cfs

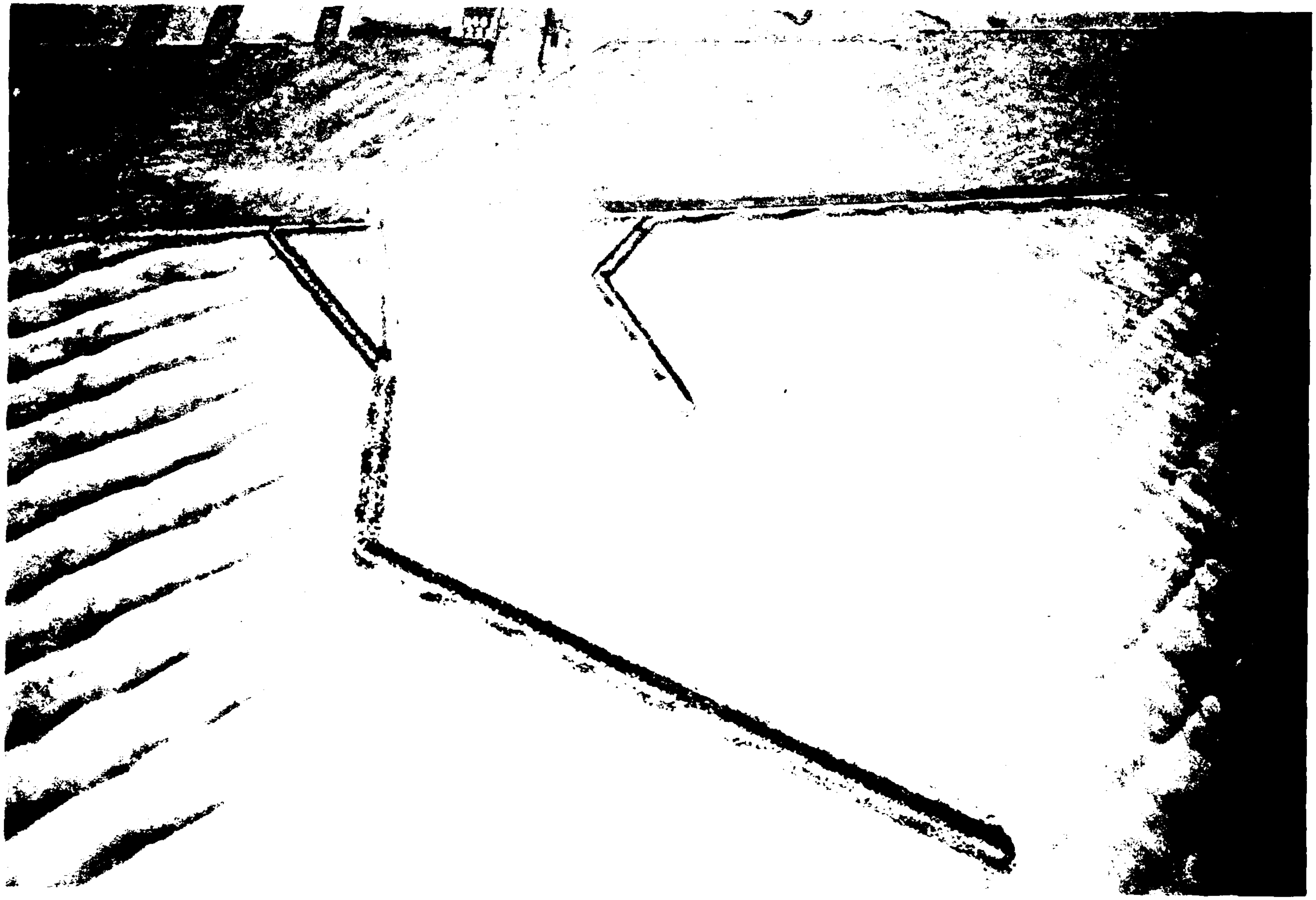


Photo 146. Typical wave patterns for Severe-Weather Plan 13D; 10-sec, 9.2-ft waves from 279 deg; +4.8 ft swl; river discharge 800 cfs

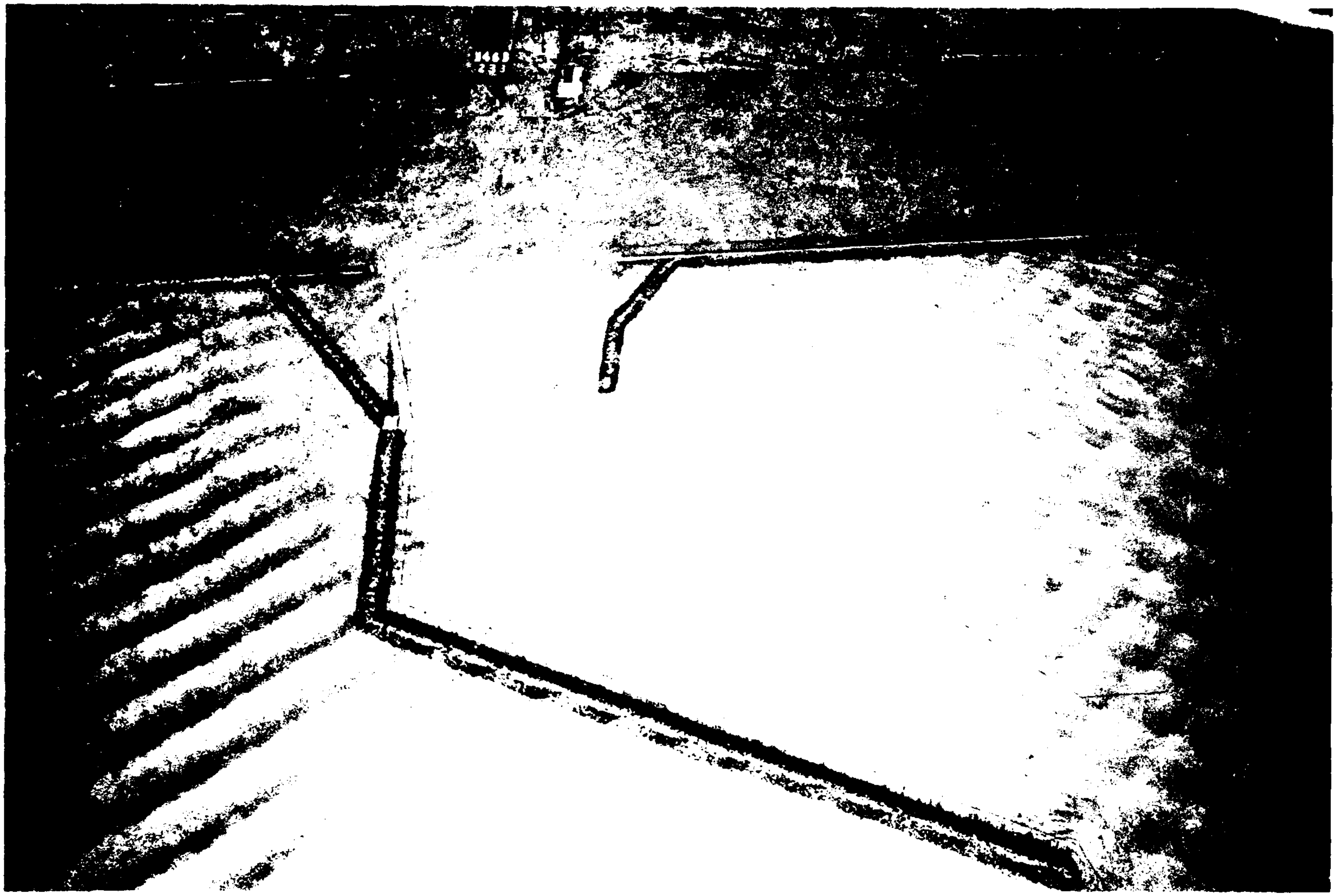


Photo 147. Typical wave patterns for Severe-Weather Plan 14; 8-sec, 6.6-ft waves from 279 deg; +4.8 ft swl; river discharge 800 cfs

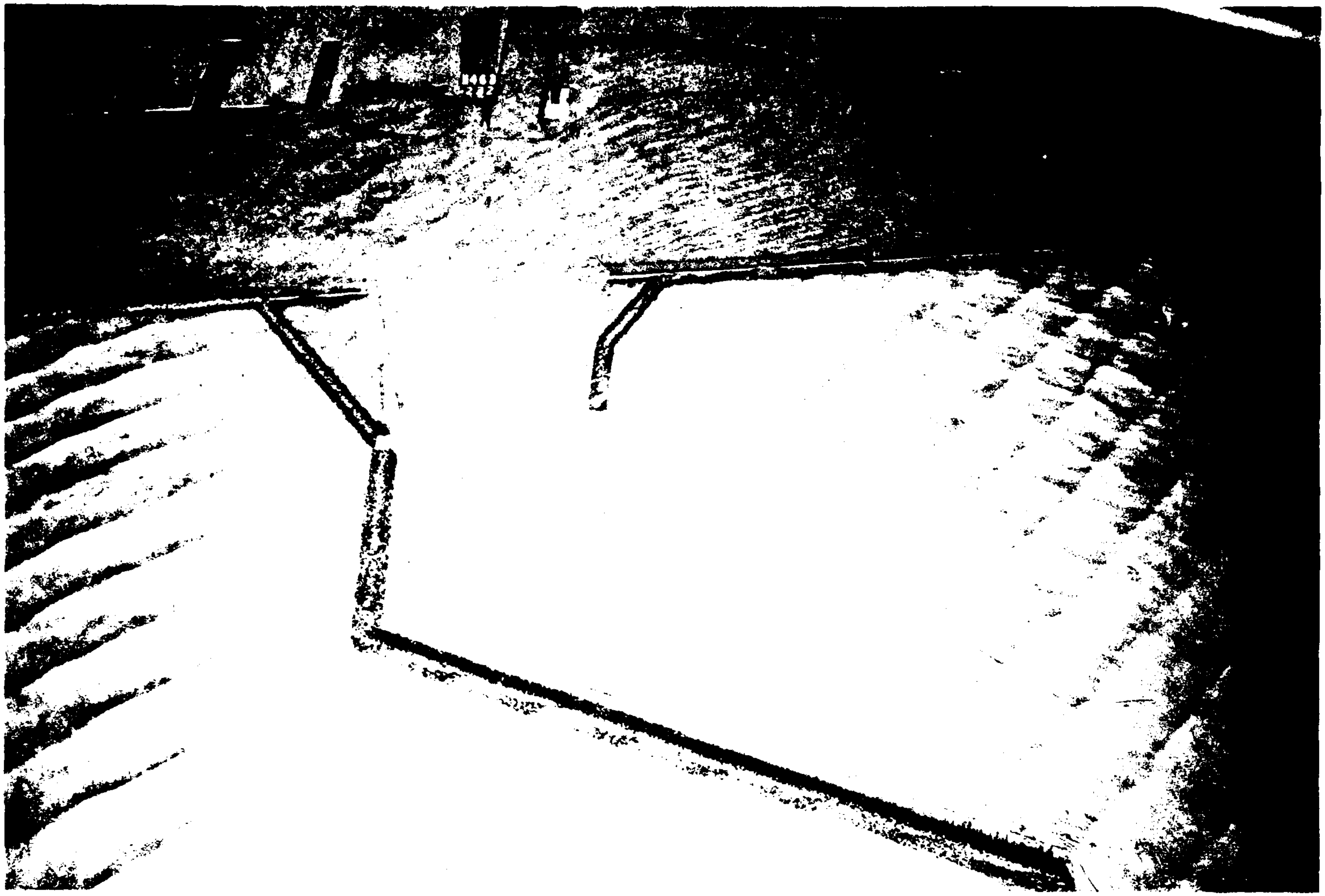


Photo 148. Typical wave patterns for Severe-Weather Plan 14; 10-sec, 9.2-ft waves from 279 deg; +4.8 ft swl; river discharge 800 cfs

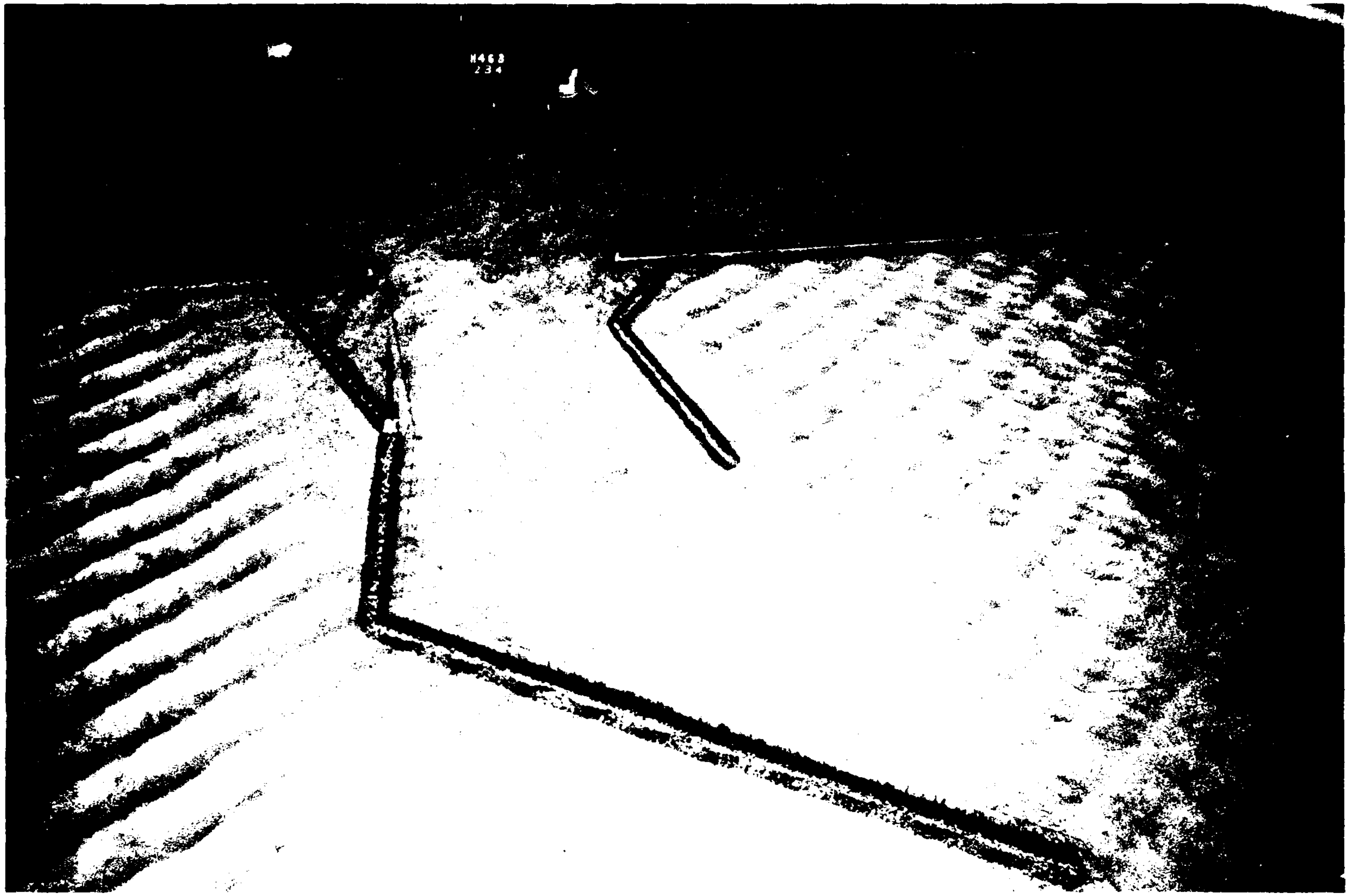



Photo 149. Typical wave patterns for Severe-Weather Plan 14A; 8-sec, 6.6-ft waves from 279 deg; +4.8 ft swl; river discharge 800 cfs

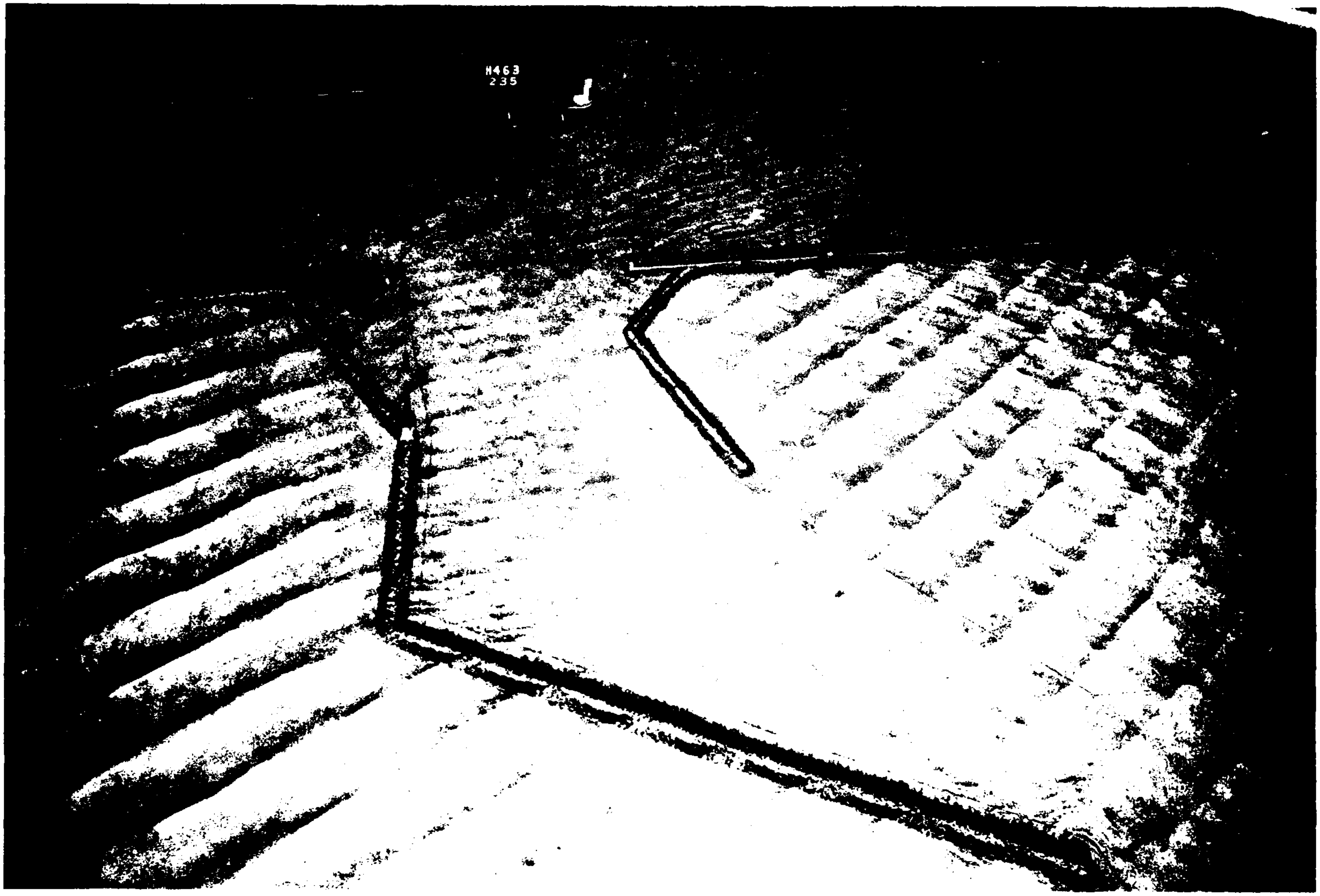



Photo 150. Typical wave patterns for Severe-Weather Plan 14A; 10-sec, 9.2-ft waves from 279 deg; +4.8 ft swl; river discharge 800 cfs

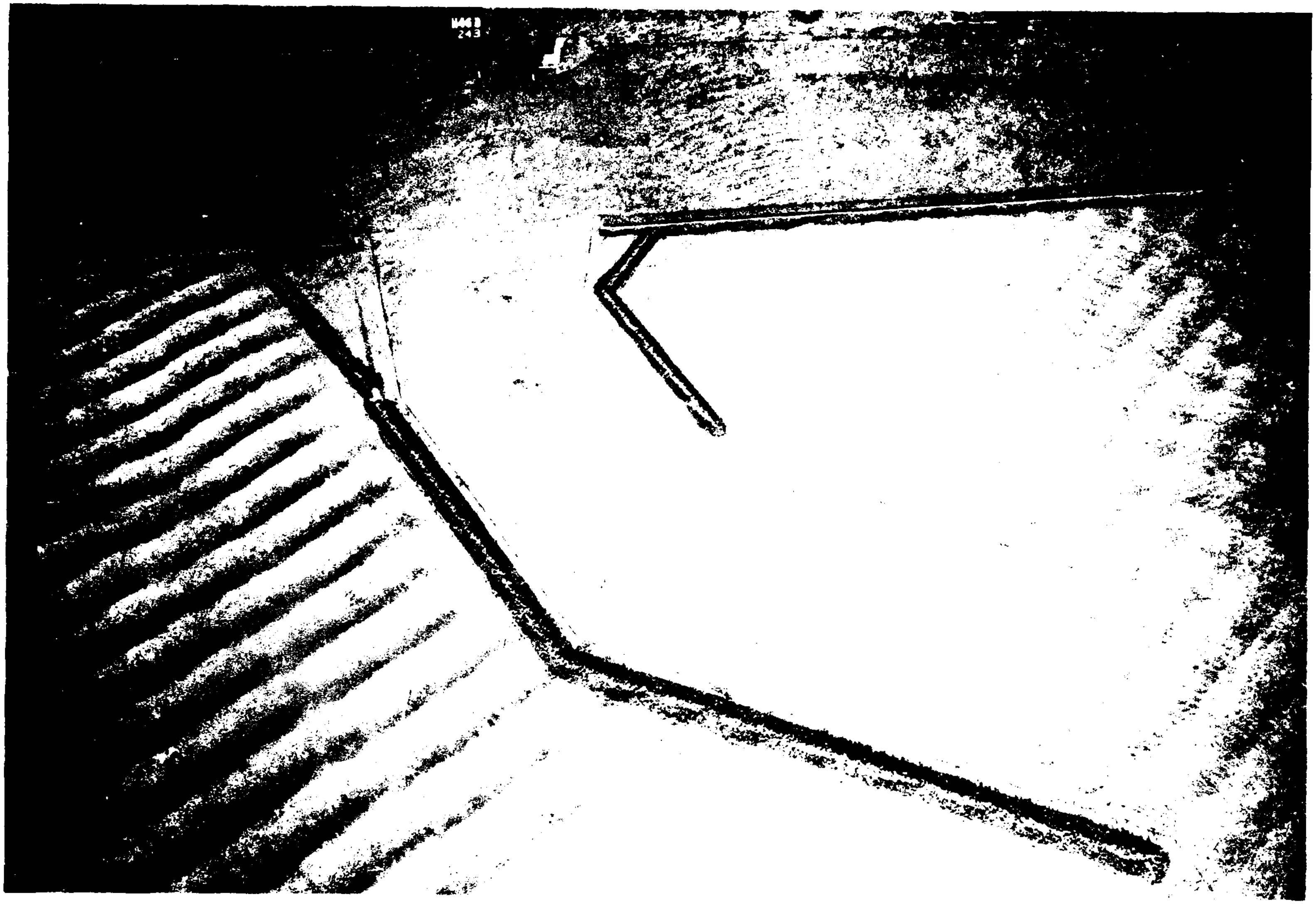


Photo 151. Typical wave patterns for Severe-Weather Plan 15; 8-sec, 6.6-ft waves from 279 deg; +4.8 ft swl; river discharge 800 cfs

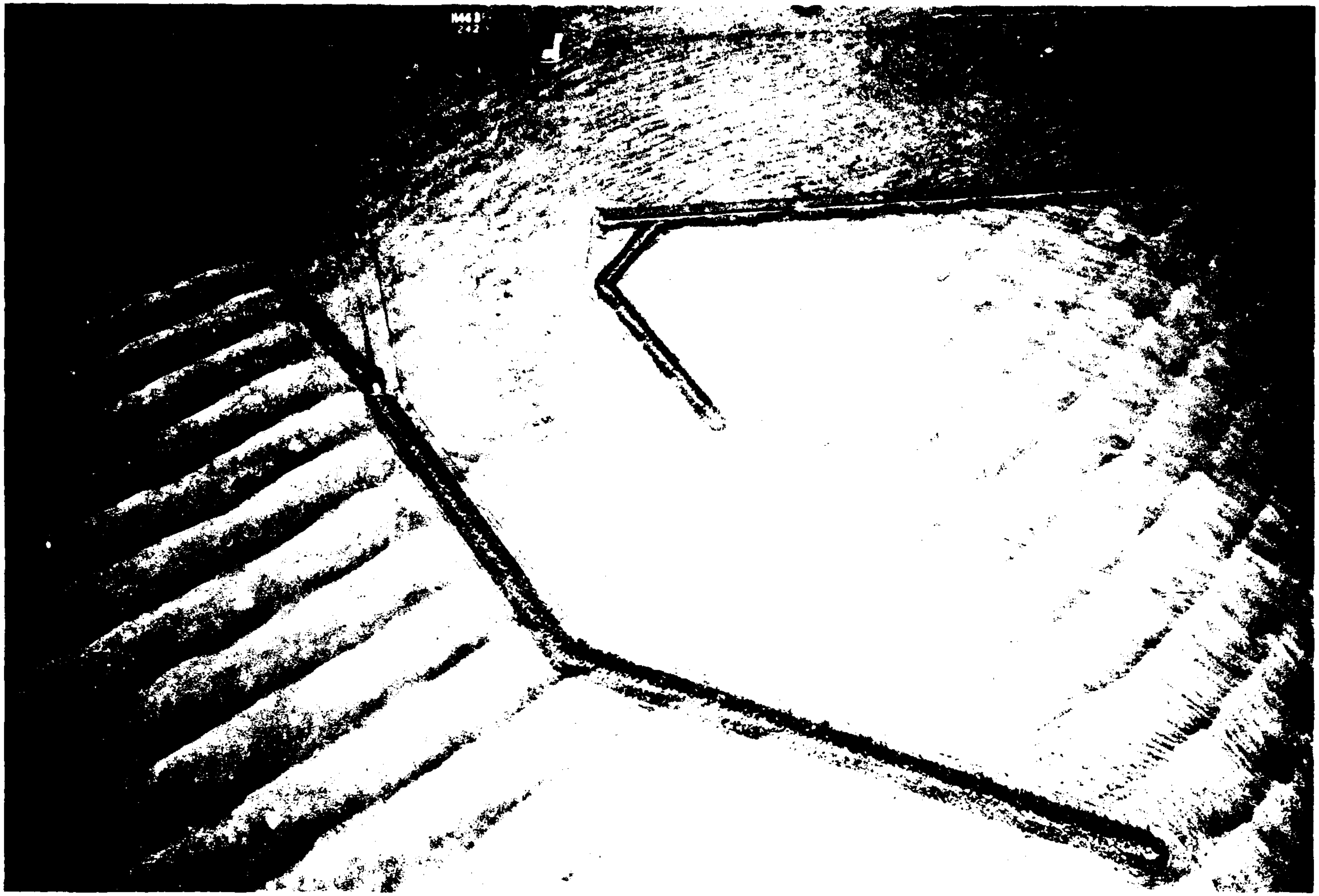


Photo 152. Typical wave patterns for Severe-Weather Plan 15; 10-sec, 9.2-ft waves from 279 deg; +4.8 ft swl; river discharge 800 cfs

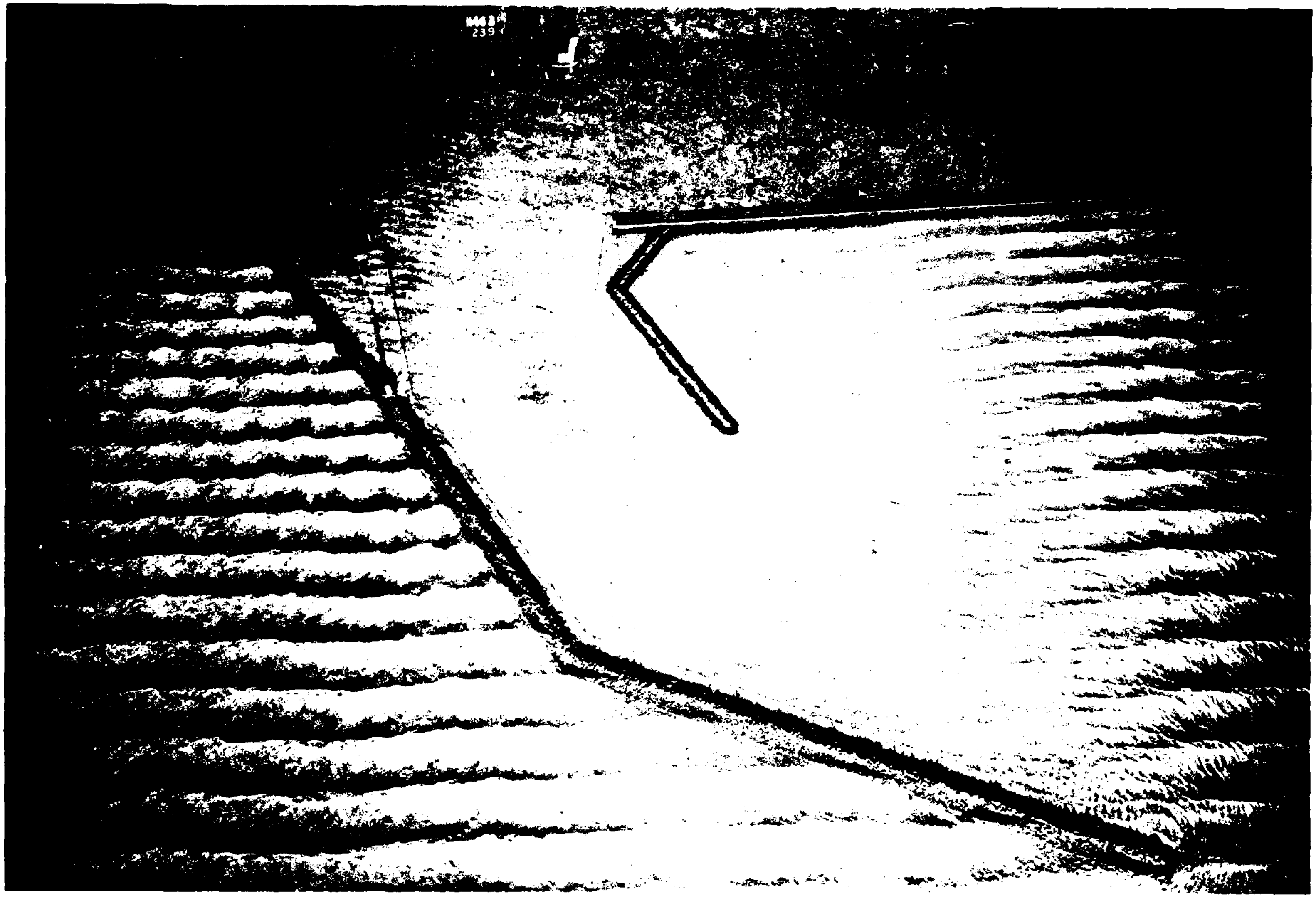


Photo 153. Typical wave patterns for Severe-Weather Plan 15; 7-sec, 8-ft waves from 326 deg; +4.8 ft swl; river discharge 800 cfs

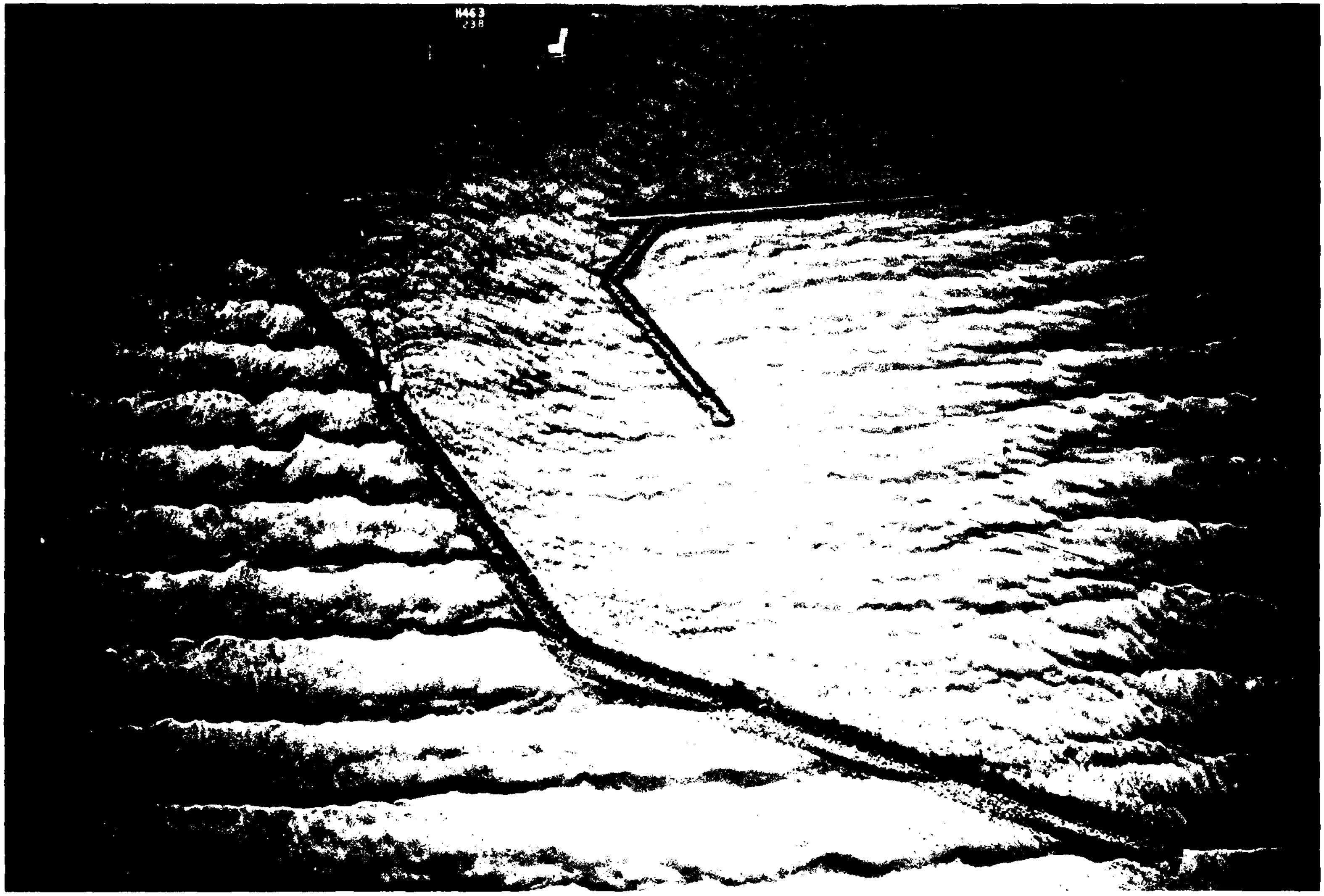



Photo 154. Typical wave patterns for Severe-Weather Plan 15; 10-sec, 13.7-ft waves from 326 deg; +4.8 ft swl; river discharge 800 cfs

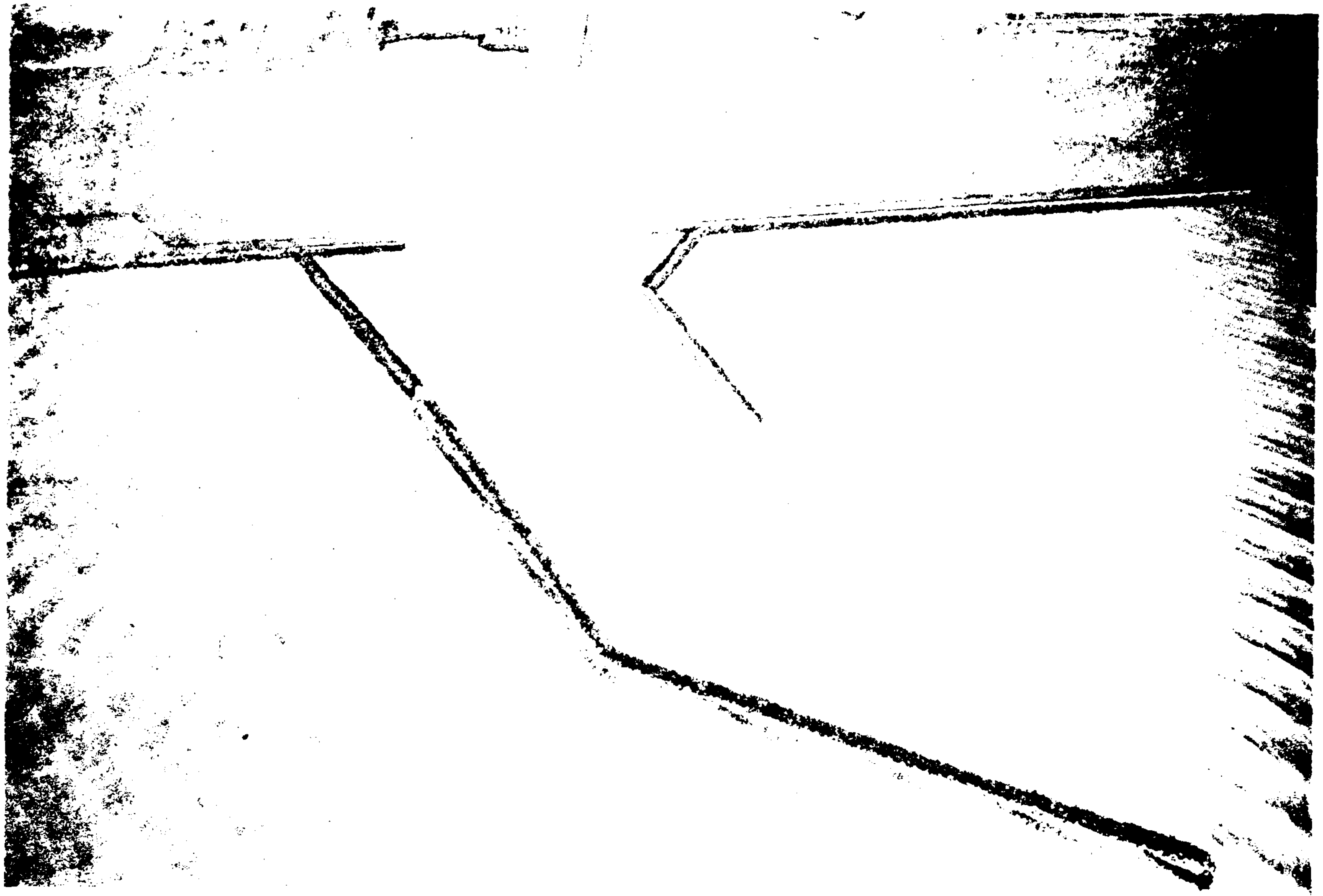


Photo 155. Typical wave patterns for Severe-Weather Plan 15; 7-sec, 7.3-ft waves from 17 deg; +4.8 ft swl; river discharge 800 cfs

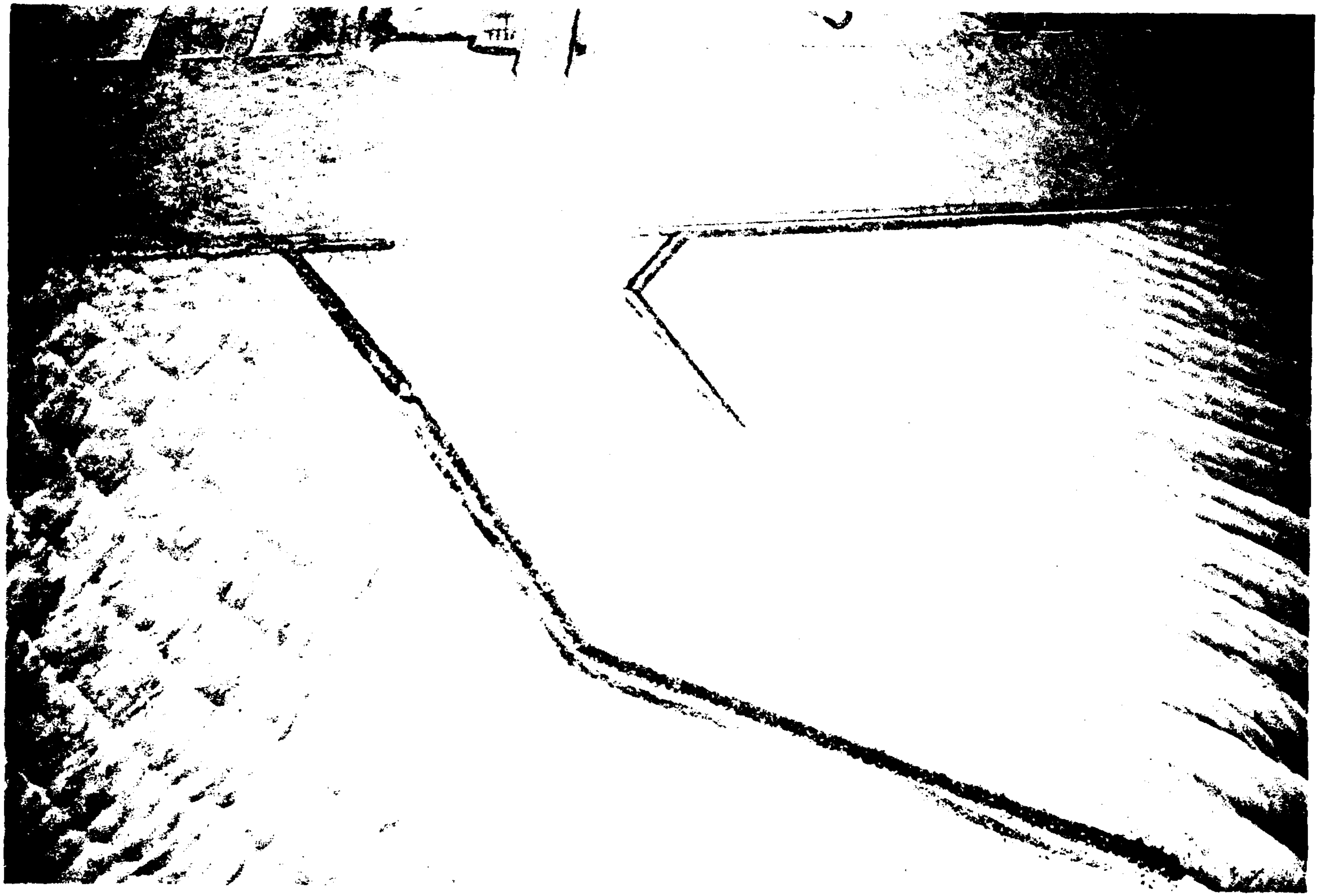


Photo 156. Typical wave patterns for Severe-Weather Plan 15; 9.5-sec, 12.2-ft waves from 17 deg; +4.8 ft swl; river discharge 800 cfs

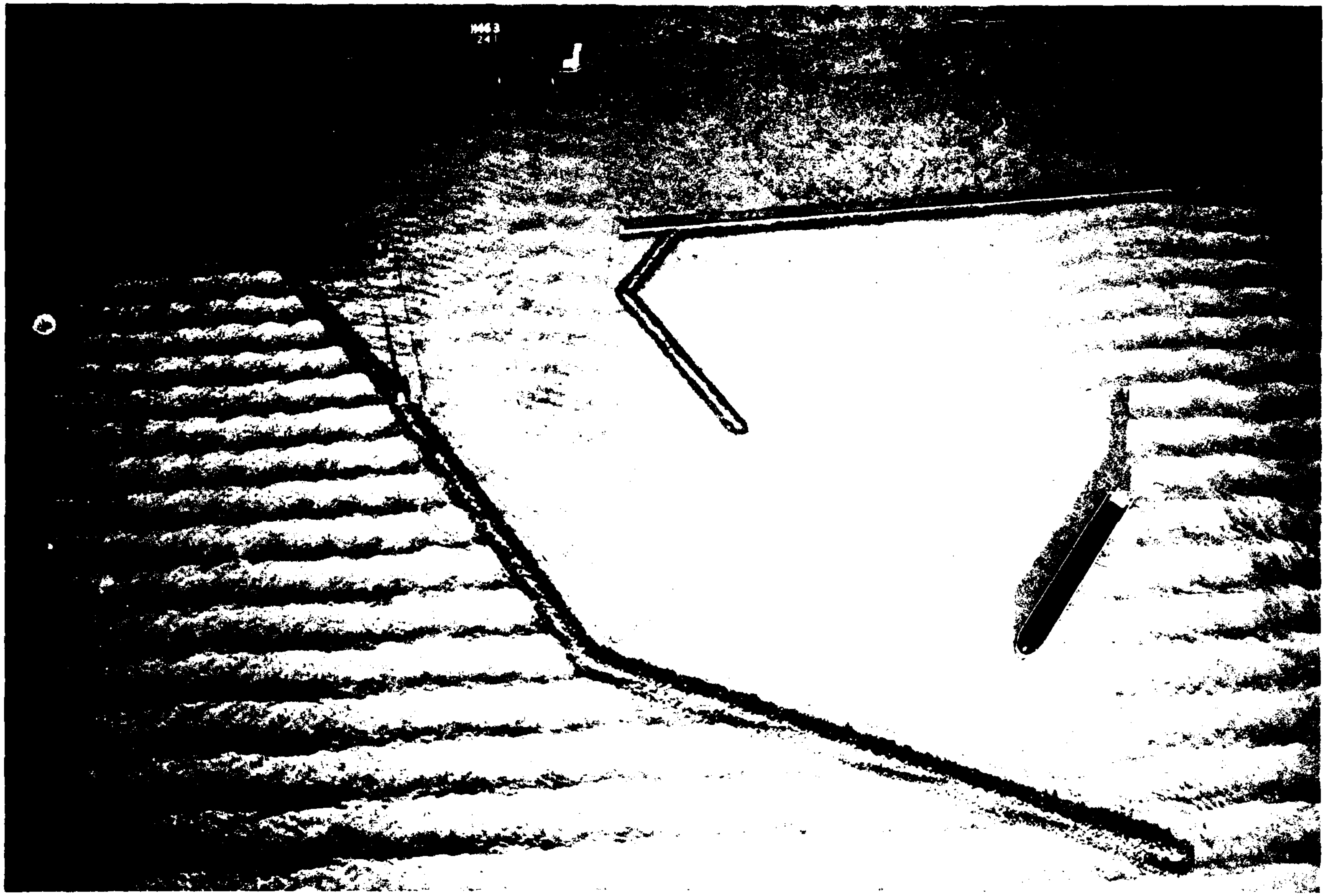


Photo 157. Simulated 30-knot winds and 7-sec, 8-ft test waves from 326 deg tend to set the vessel's stern toward shore and its bow toward the Severe-Weather Plan 15 east breakwater at slow speeds

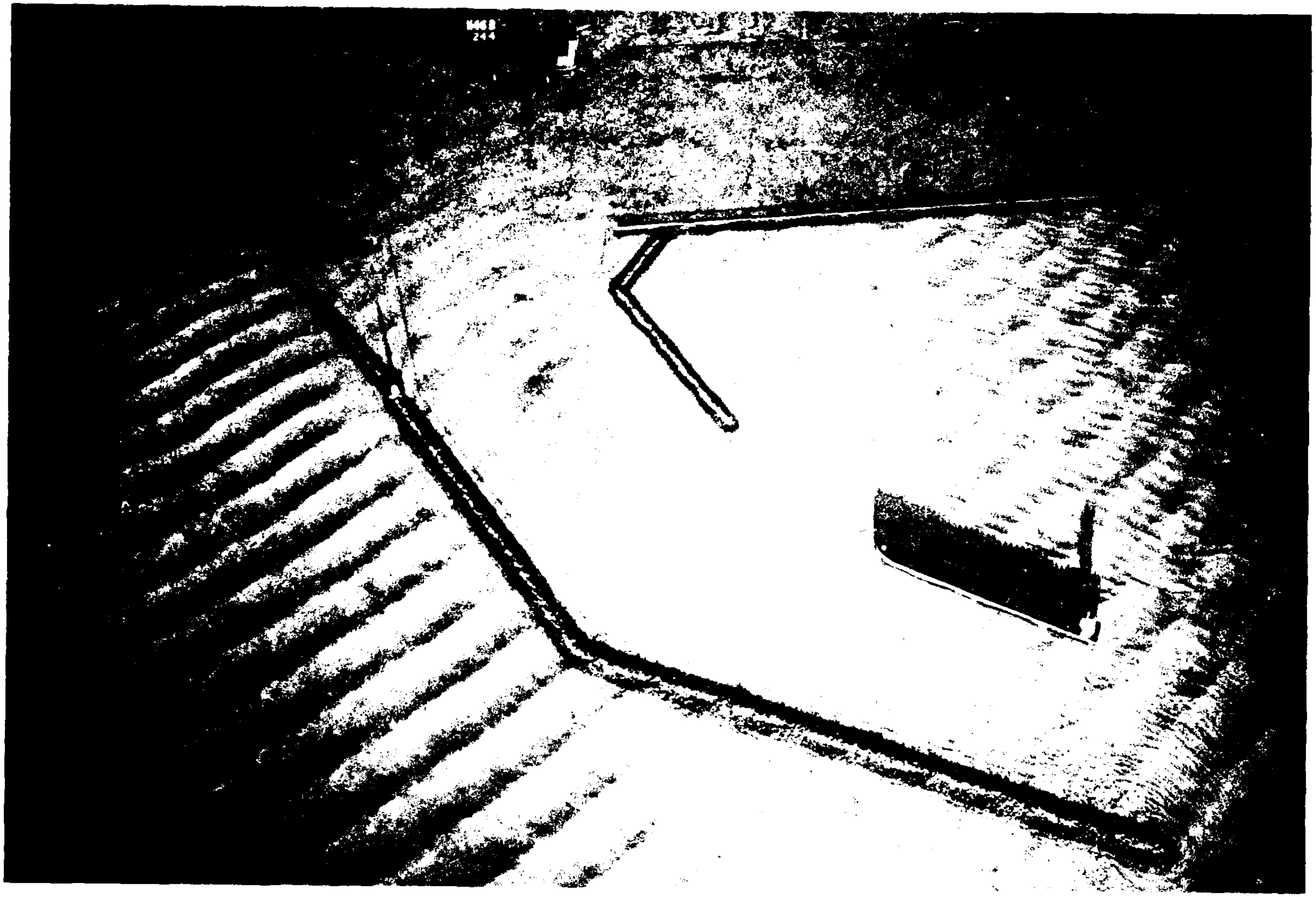


Photo 158. 1,000-ft-long ore carrier entering the Severe-Weather Plan 15 harbor entrance while under attack by 8-sec, 6.6-ft wages from 279 deg

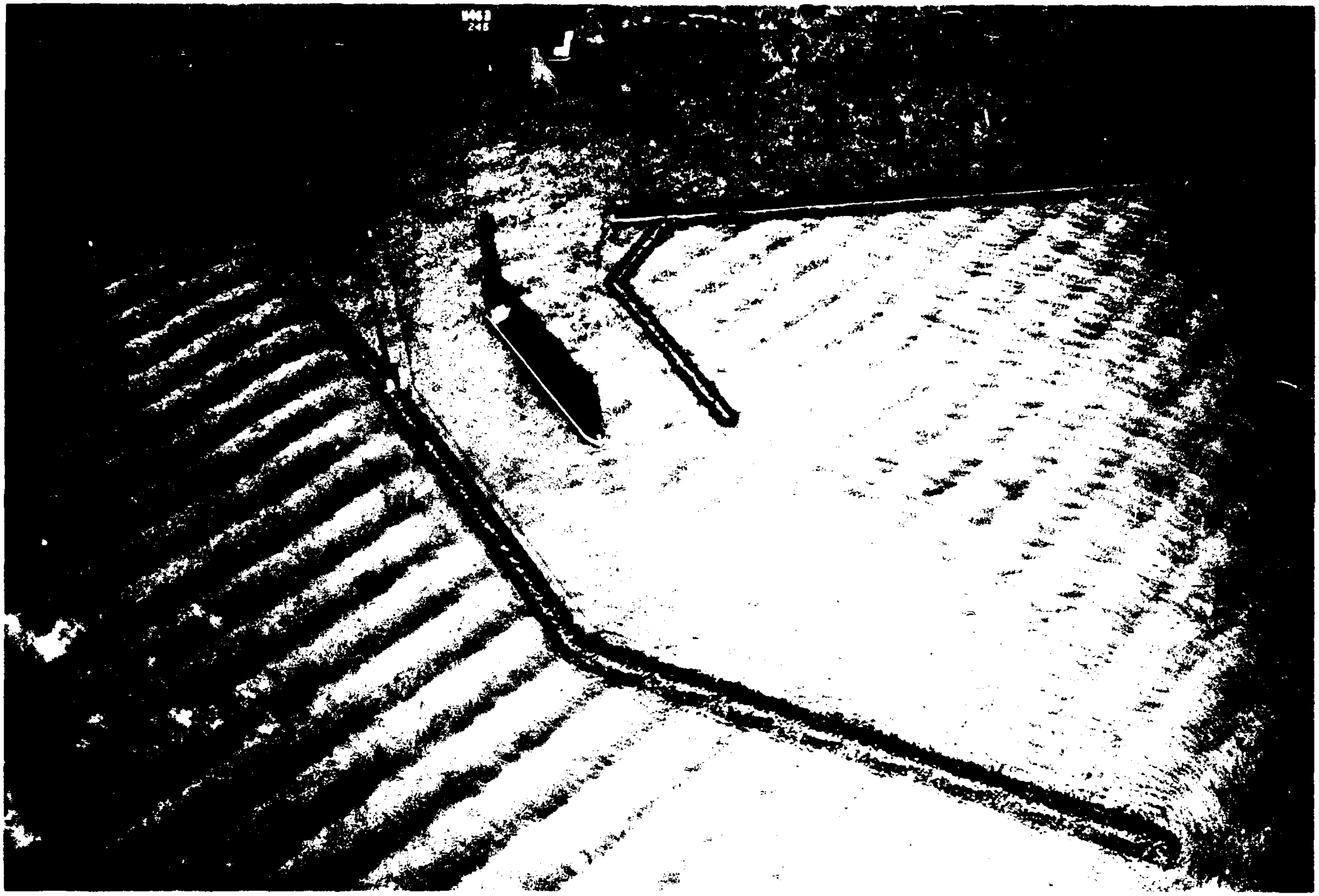


Photo 159. Model vessel leaving harbor while under attack by 8-sec, 6.6-ft waves from 279 deg; Severe-Weather Plan 15

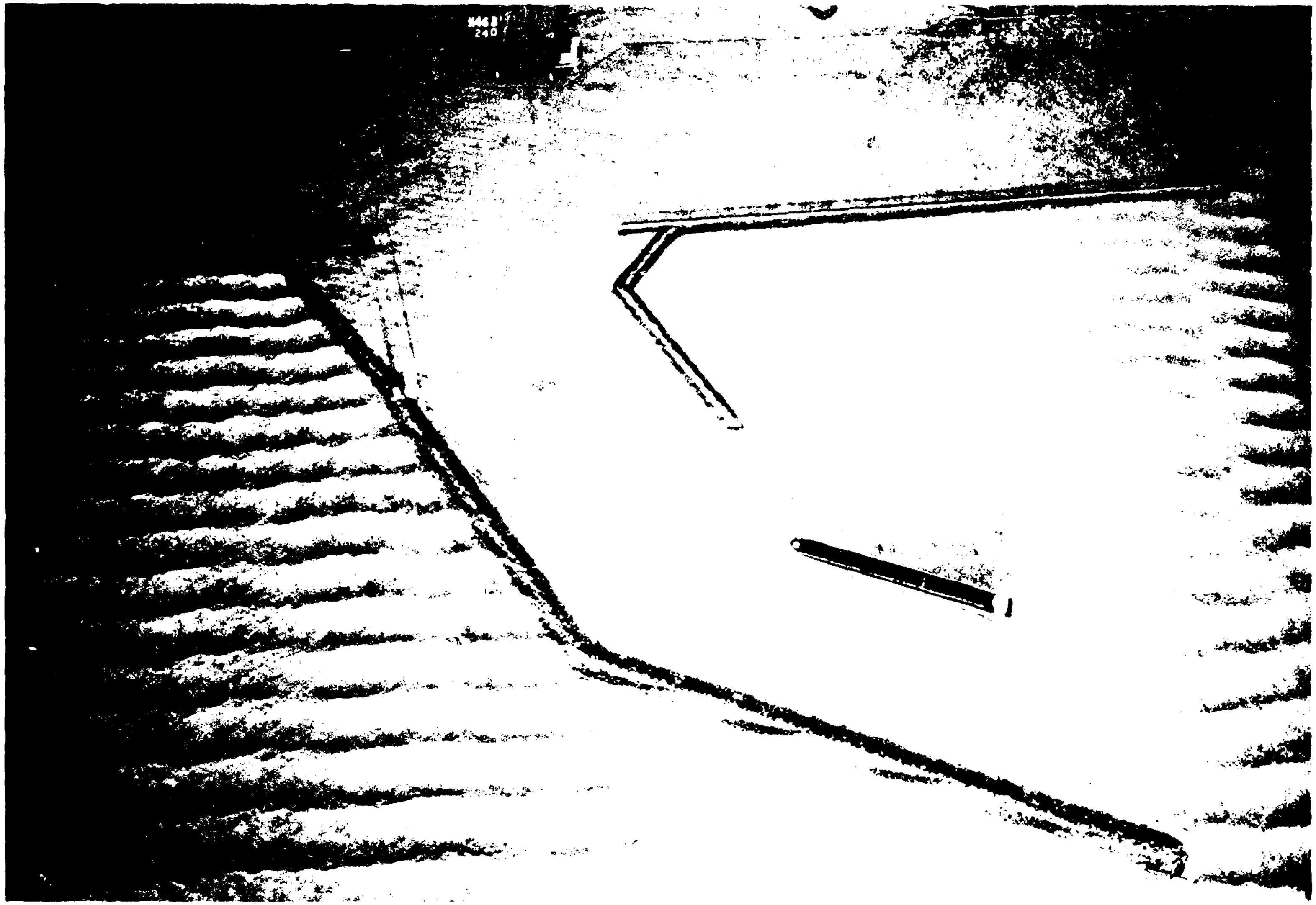


Photo 160. 1,000-ft-long ore carrier entering harbor with Severe-Weather Plan 15 installed while under attack by *7-sec, 8-ft waves from 326 deg*

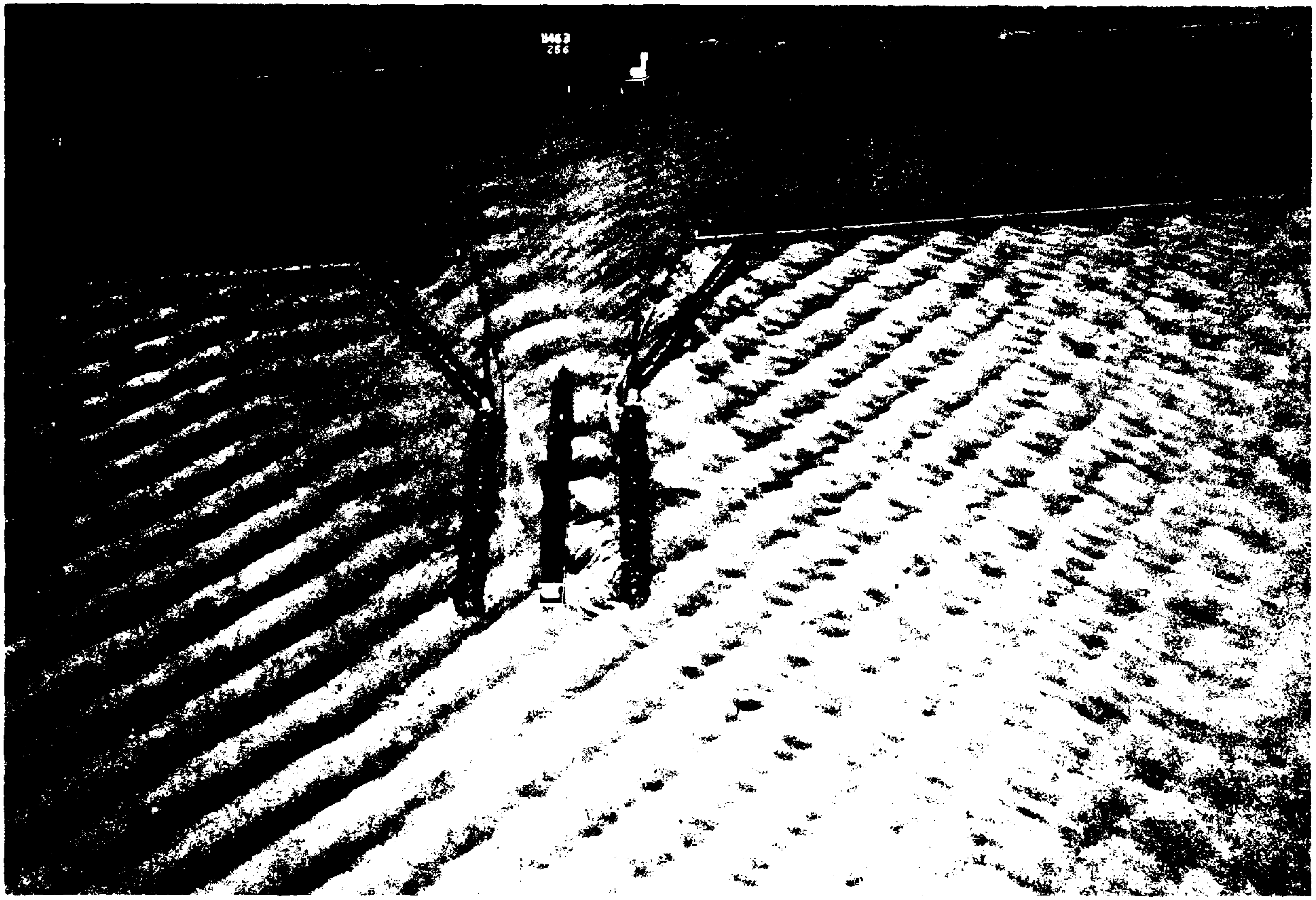


Photo 161. 1,000-ft-long ore carrier entering the Severe-Weather Plan 16 harbor entrance while under attack by 8-sec, 6.6-ft waves from 279 deg


Photo 162. Model vessel leaving harbor while under attack by 8-sec, 6.6-ft waves from 279 deg; Severe-Weather Plan 16

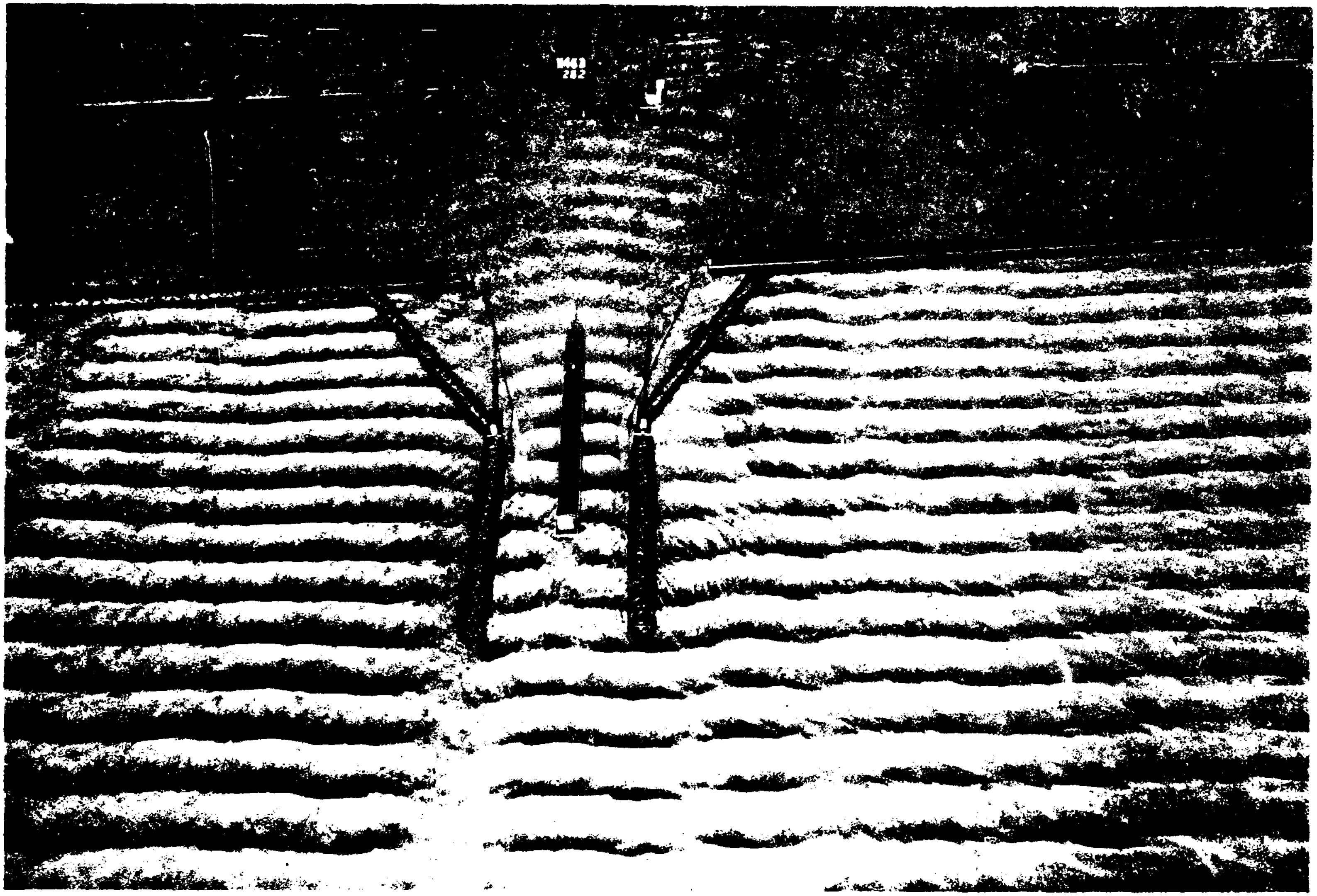


Photo 163. Model ore carrier entering the harbor with Severe-Weather Plan 16 installed while under attack by 7-sec, 8-ft waves from 326 deg

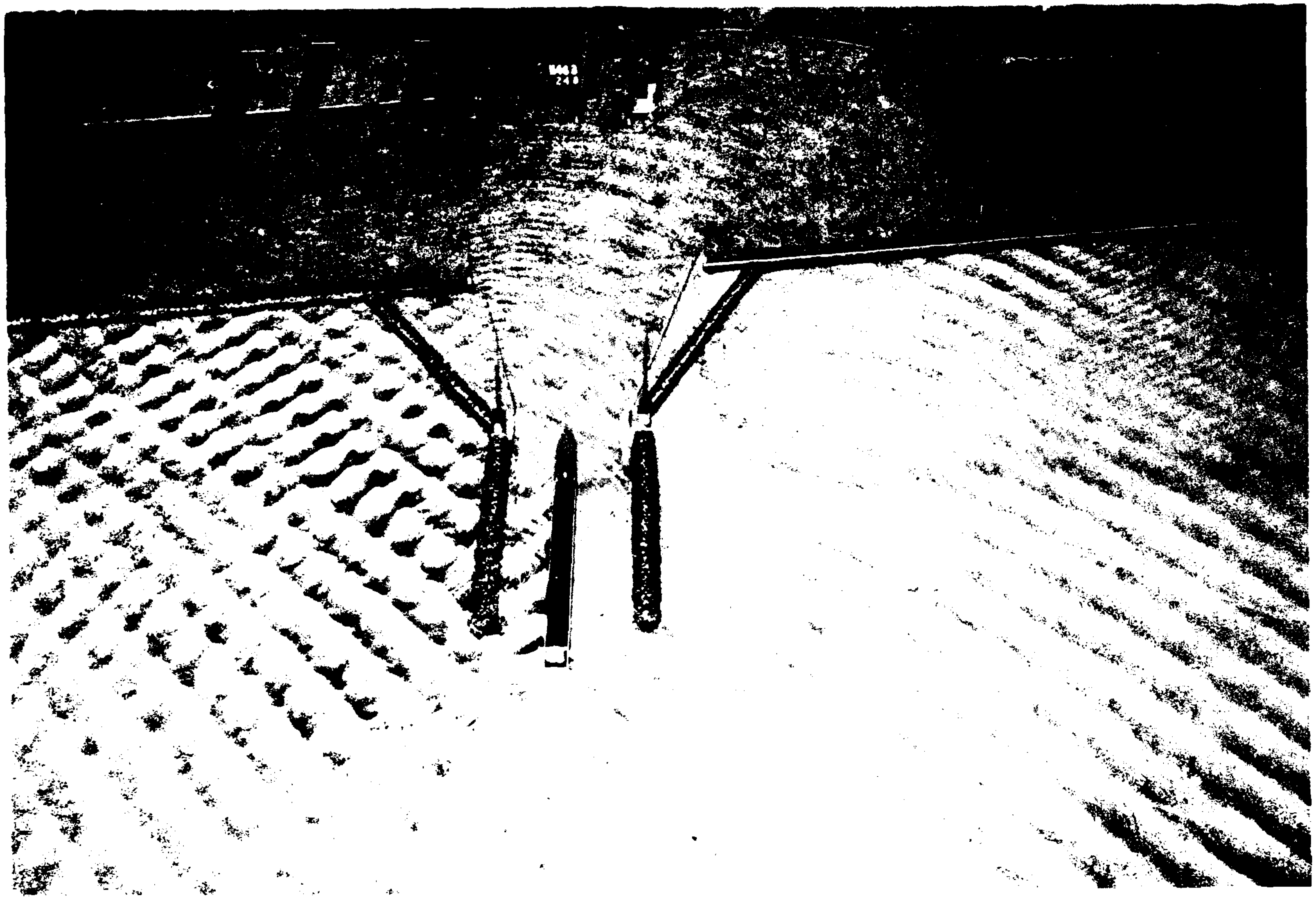


Photo 164. 1,000-ft-long ore carrier entering the Severe-Weather Plan 16 harbor entrance while under attack by 7-sec, 7.3-ft waves from 17 deg

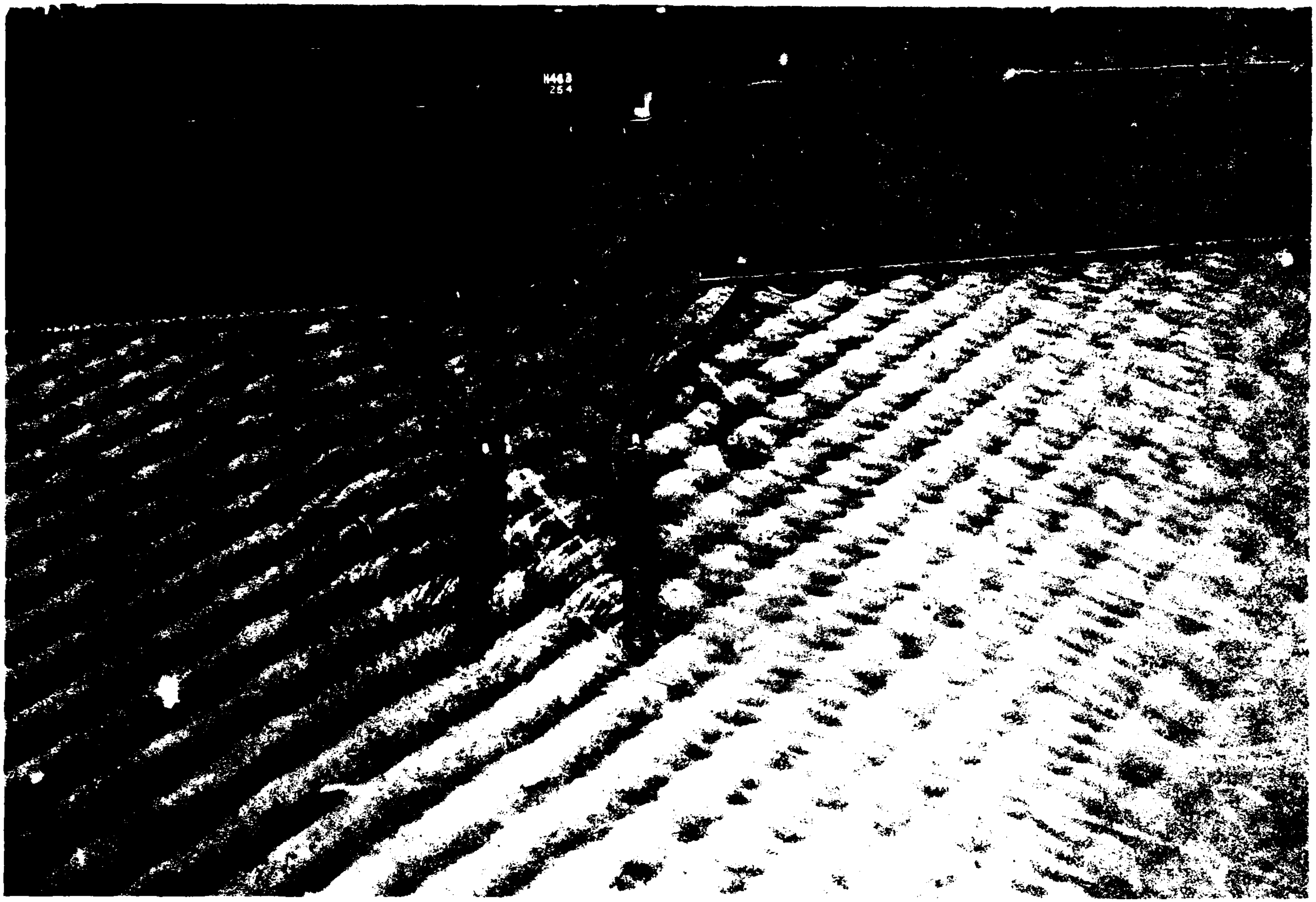



Photo 165. Typical wave patterns for Severe-Weather Plan 16; 8-sec, 6.6-ft waves from 279 deg; +4.8 ft swl; river discharge 800 cfs

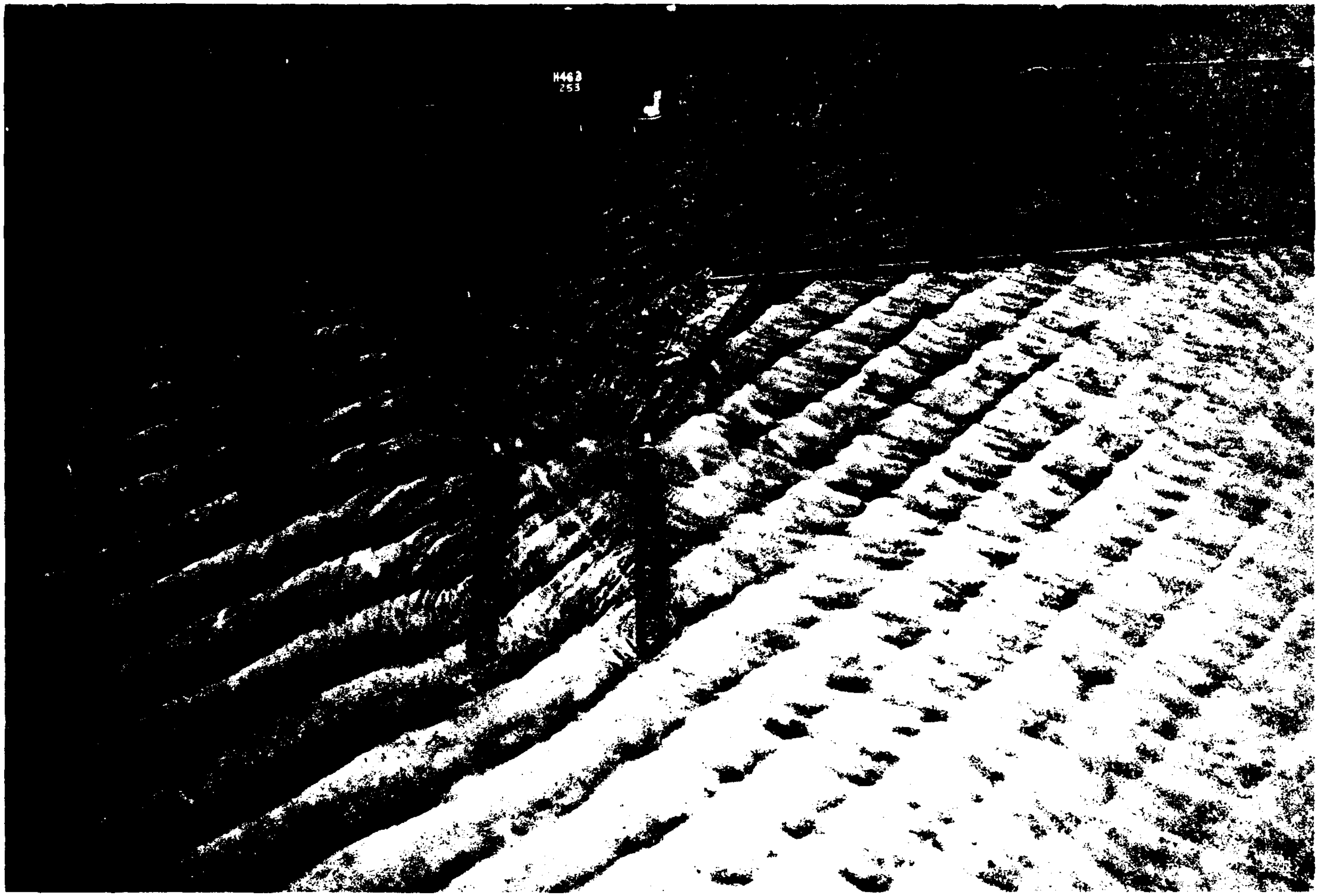



Photo 166. Typical wave patterns for Severe-Weather Plan 16; 10-sec, 9.2-ft waves from 279 deg; +4.8 ft swl; river discharge 800 cfs

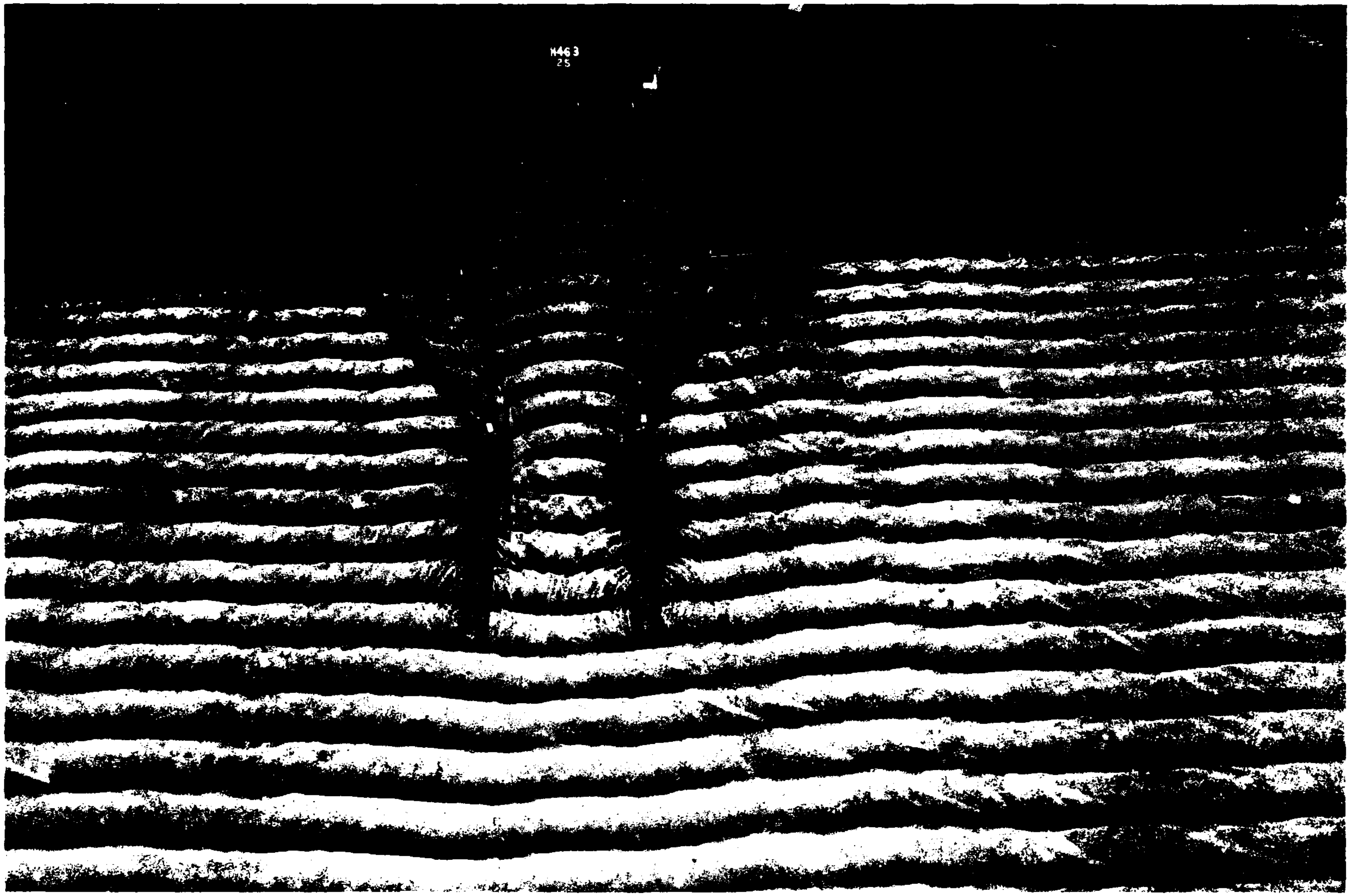


Photo 167. Typical wave patterns for Severe-Weather Plan 16; 7-sec, 8-ft waves from 326 deg; +4.8 ft swl; river discharge 800 cfs

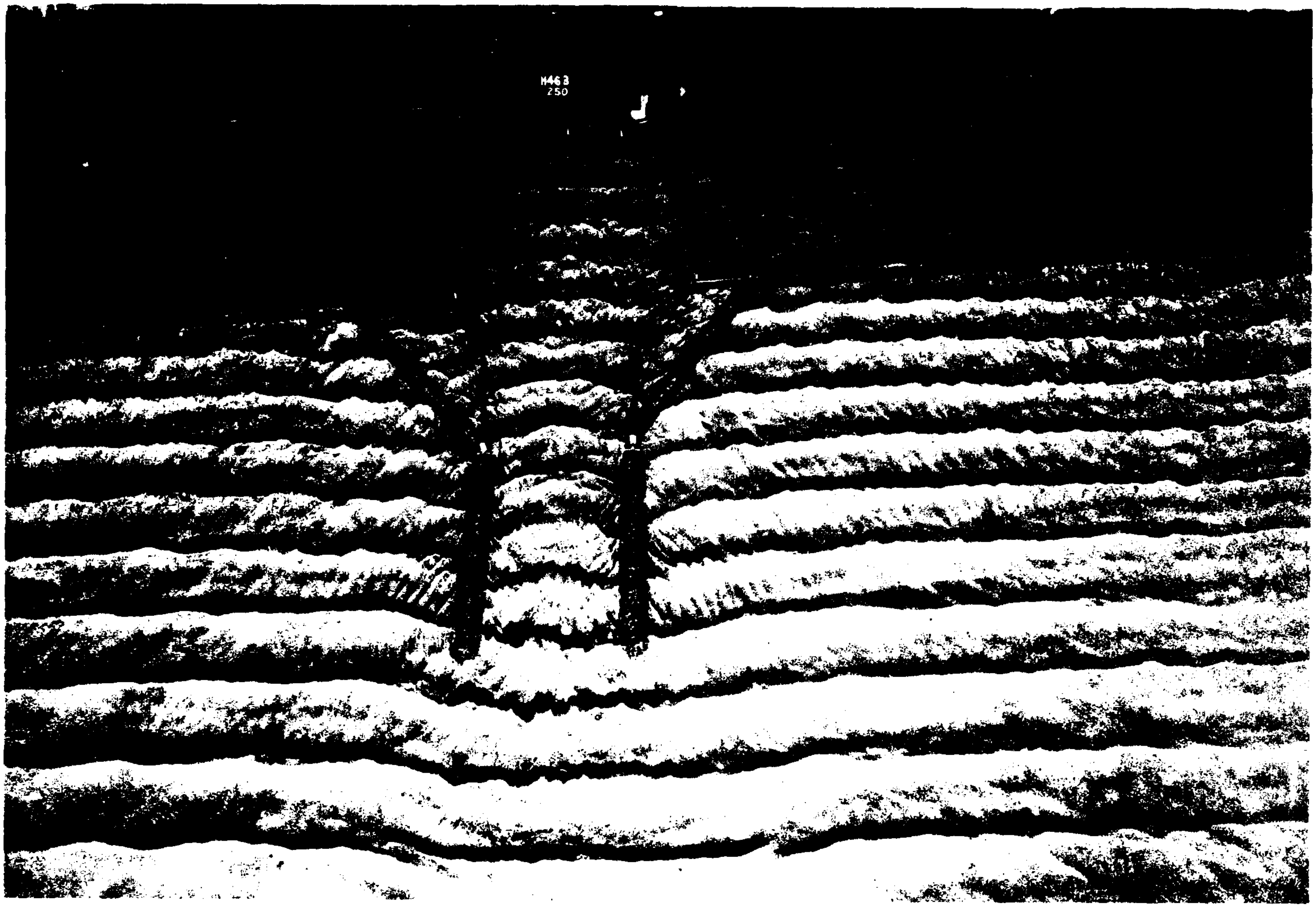



Photo 168. Typical wave patterns for Severe-Weather Plan 16; 10-sec, 13.7-ft waves from 326 deg; +4.8 ft swl; river discharge 800 cfs

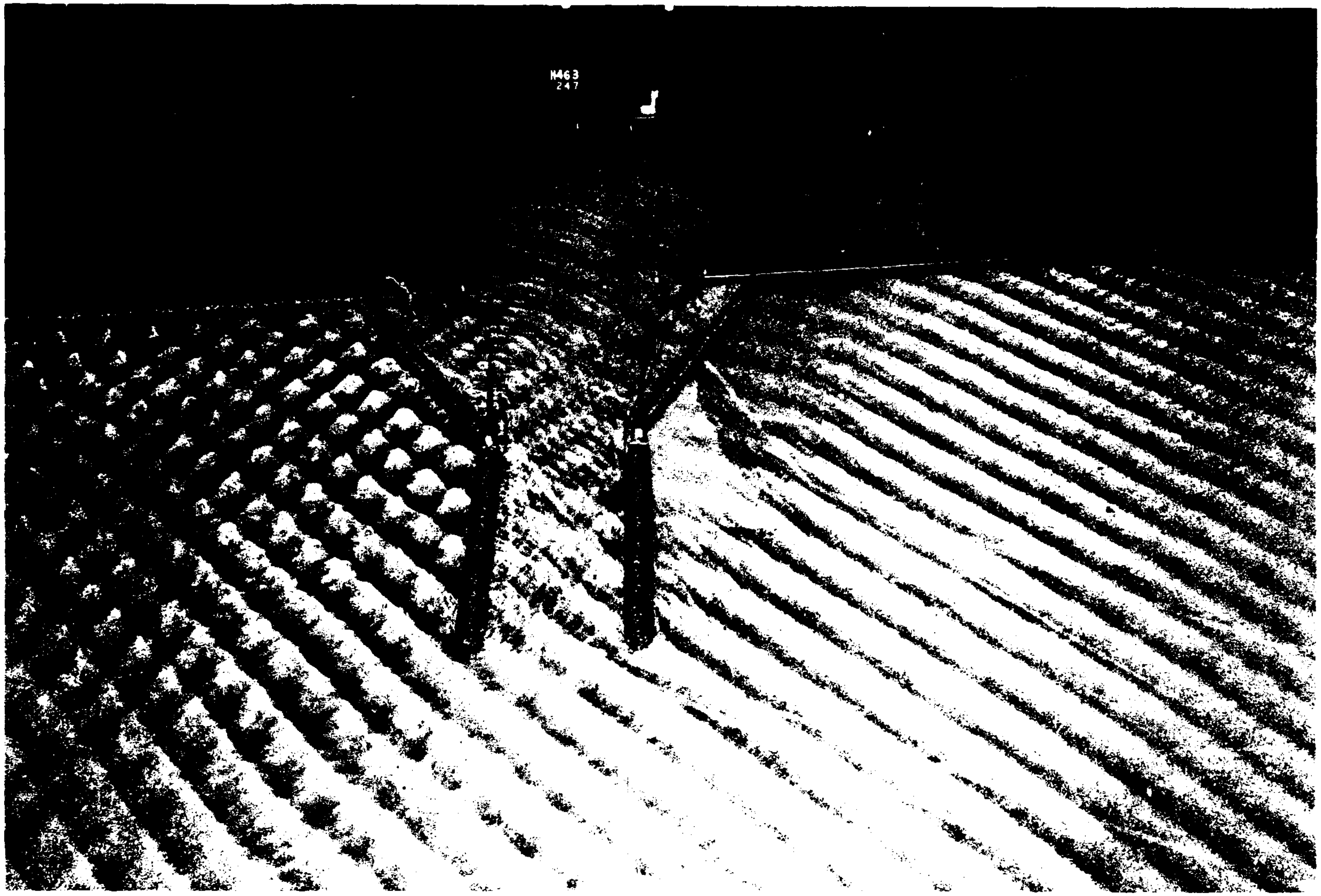



Photo 169. Typical wave patterns for Severe-Weather Plan 16; 7-sec, 7.3-ft waves from 17 deg; +4.8 ft swl; river discharge 800 cfs

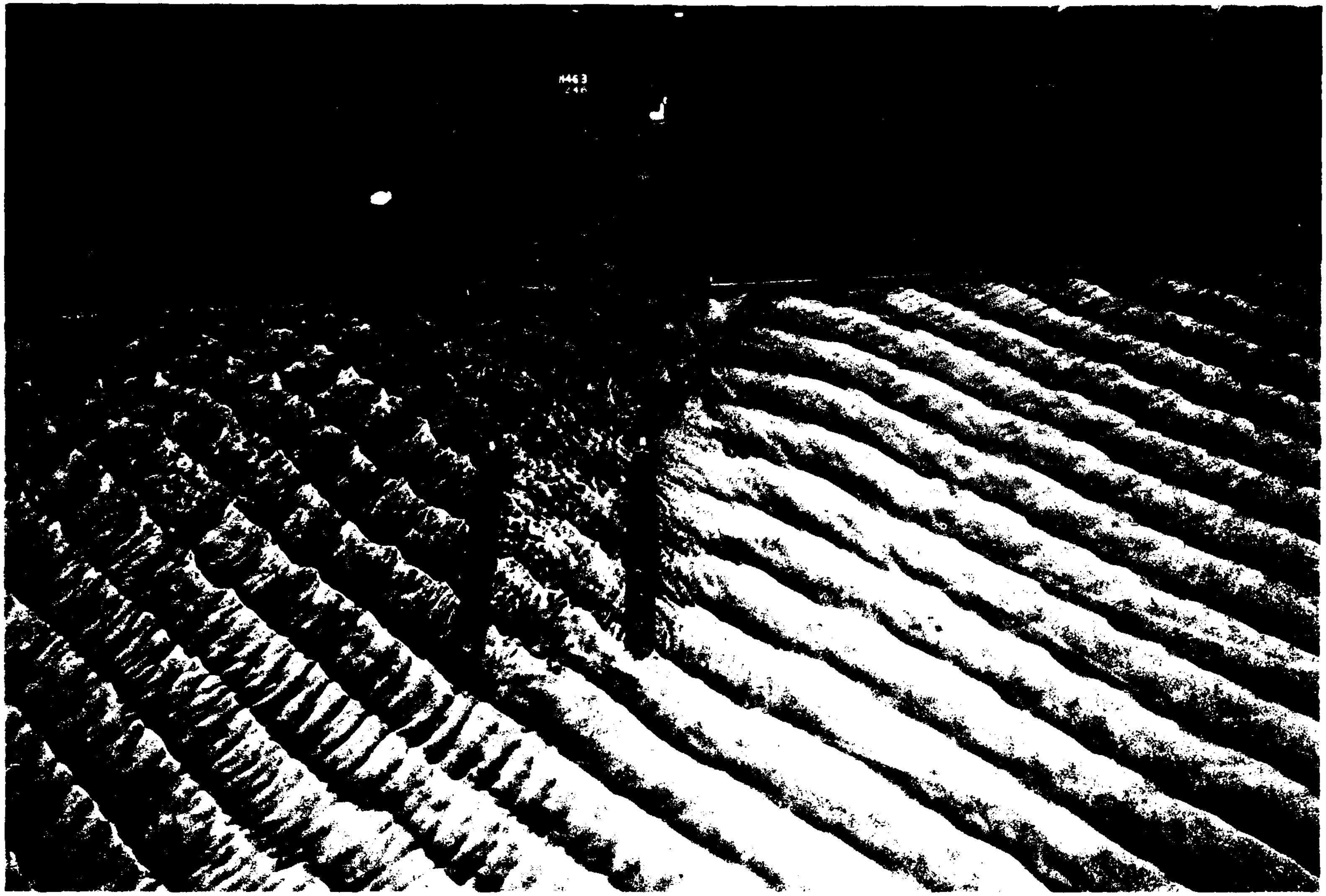
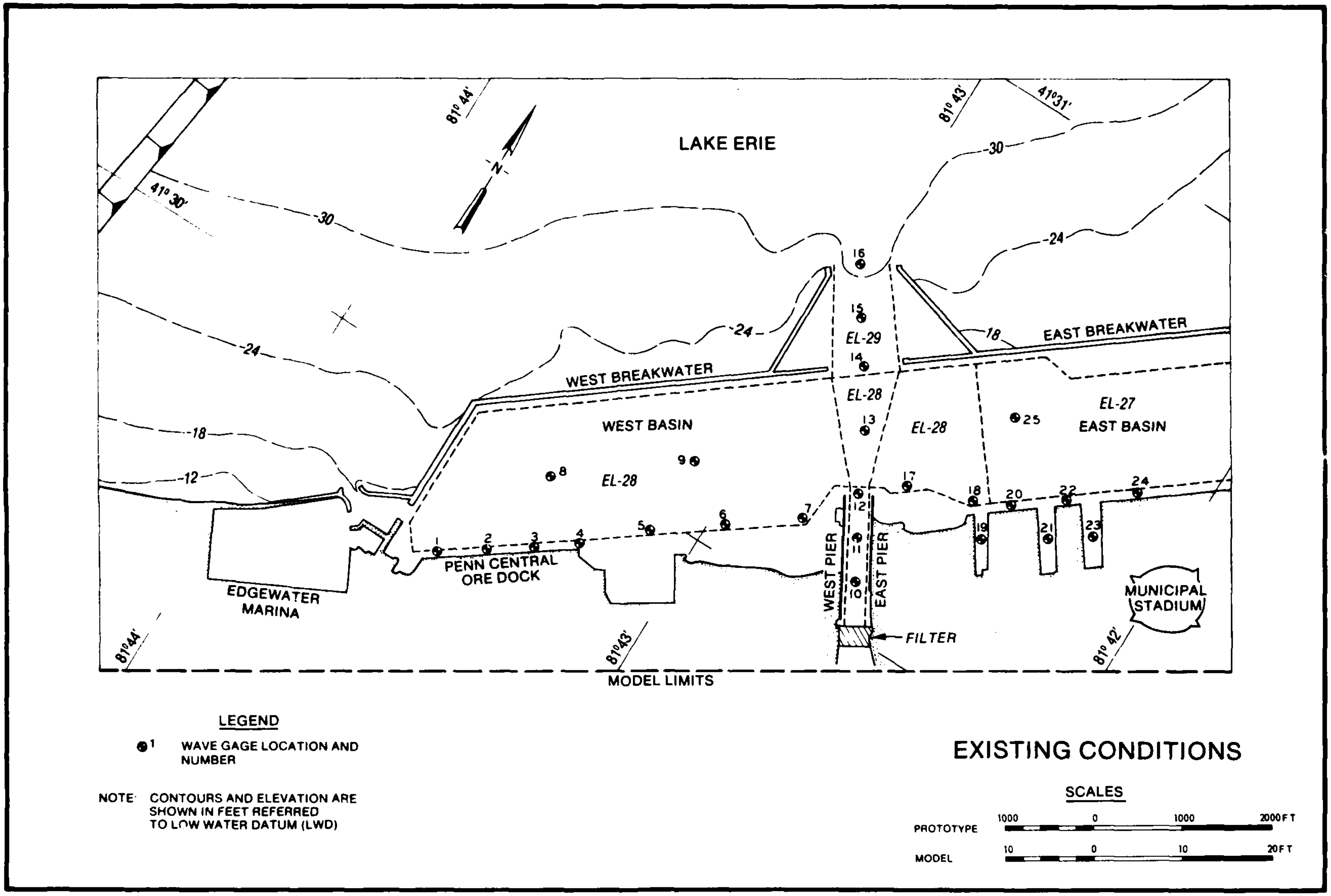
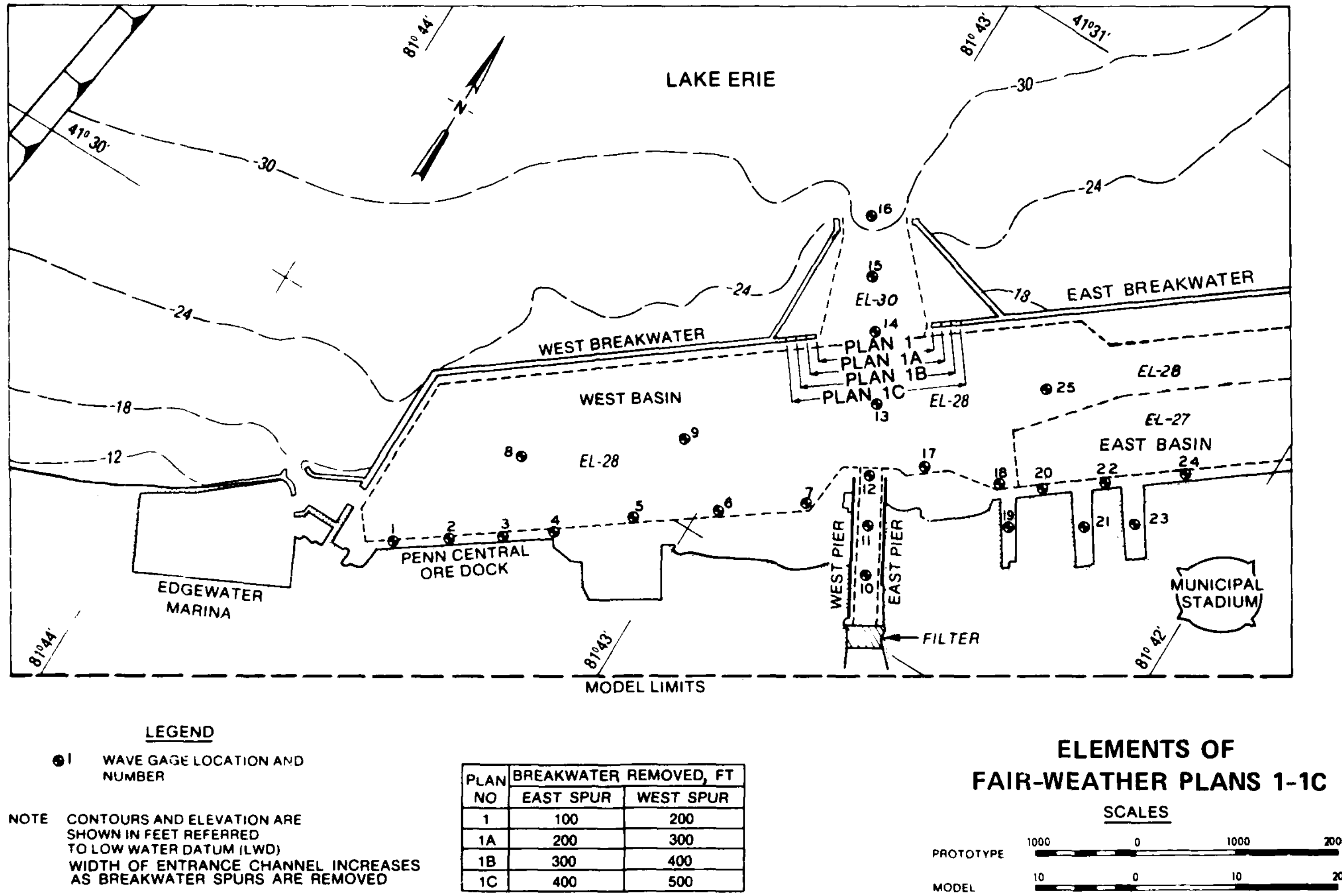


Photo 170. Typical wave patterns for Severe-Weather Plan 16; 9.5-sec, 12.2-ft waves from 17 deg; +4.8 ft swl; river discharge 800 cfs


LAKE ERIE
81° 44'
81° 43'
41°31'
41° 30'
N
30
24
18
12
16
15
EL-29
14
EL-28
13
EL-28
EAST BREAKWATER
WEST BREAKWATER
WEST BASIN
EL-28
EL-27
EAST BASIN
25
9
8
1
2
3
4
5
6
7
12
11
10
17
18
19
20
21
22
23
24
PENN CENTRAL
ORE DOCK
EDGEWATER
MARINA
WEST PIER
EAST PIER
FILTER
MUNICIPAL
STADIUM
81°44'
81°43'
81° 42'
MODEL LIMITS
LEGEND
1 WAVE GAGE LOCATION AND NUMBER
NOTE: CONTOURS AND ELEVATION ARE SHOWN IN FEET REFERRED TO LOW WATER DATUM (LWD)
EXISTING CONDITIONS
SCALES
PROTOTYPE
1000
0
1000
2000 FT
MODEL
10
0
10
20 FT

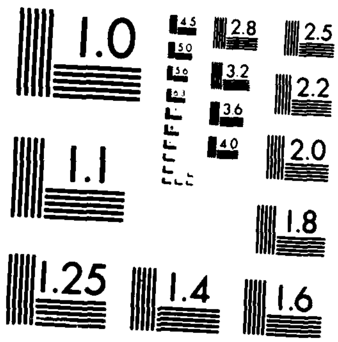



| PLAN NO | BREAKWATER REMOVED, FT | |
|---|---|---|
| | EAST SPUR | WEST SPUR |
| 1 | 100 | 200 |
| 1A | 200 | 300 |
| 1B | 300 | 400 |
| 1C | 400 | 500 |

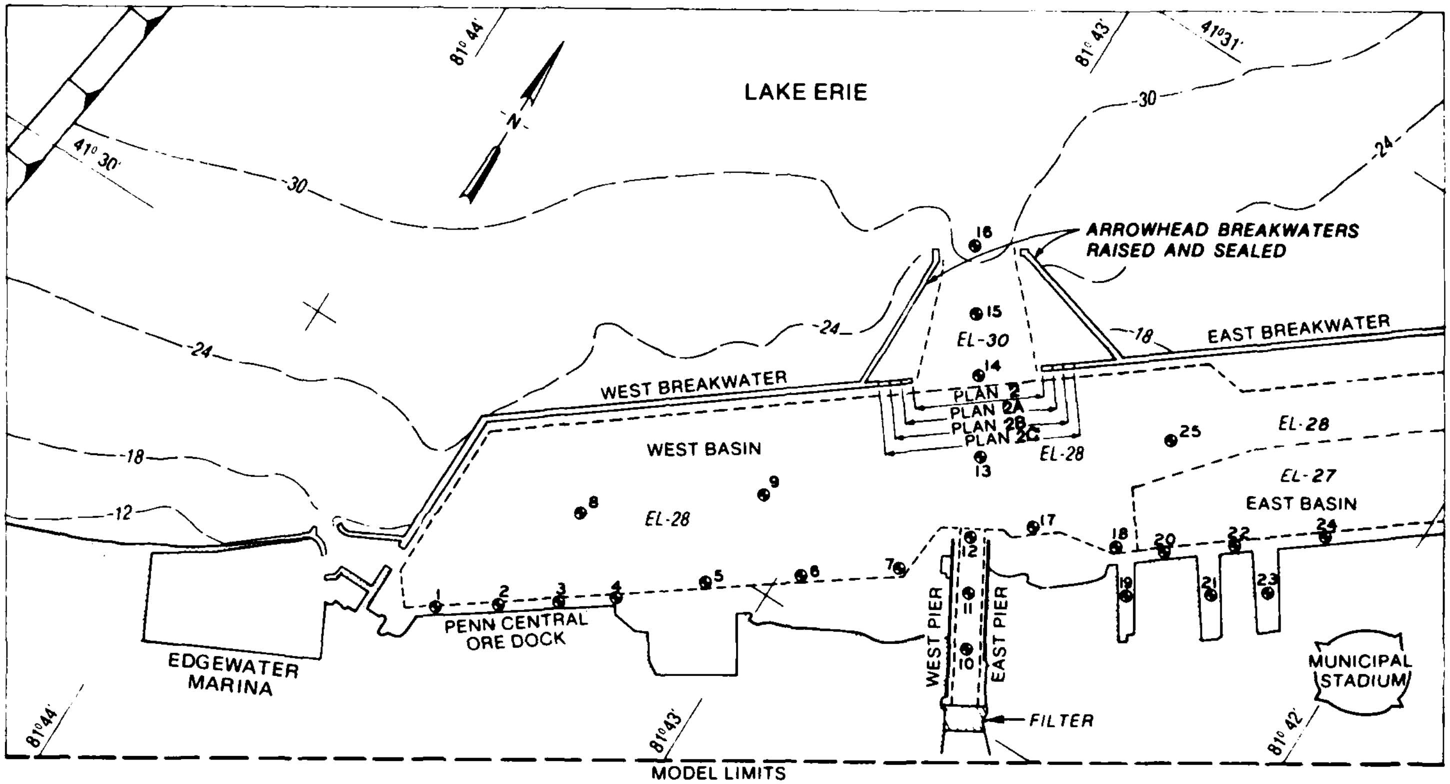
## ELEMENTS OF FAIR-WEATHER PLANS 1-1C

PLATE 2

AD-A129 783 CLEVELAND HARBOR OHIO DESIGN FOR THE SAFE AND EFFICIENT 4/4
PASSAGE OF 1000-F..(U) ARMY ENGINEER WATERWAYS
EXPERIMENT STATION VICKSBURG MS HYDRA.. R R BOTTIN
UNCLASSIFIED MAR 83 WES/TR/HL-83-6 F/G 13/2 NL




MICROCOPY RESOLUTION TEST CHART
NATIONAL BUREAU OF STANDARDS 1963 A




LEGEND

WAVE GAGE LOCATION AND NUMBER

NOTE CONTOURS AND ELEVATION ARE SHOWN IN FEET REFERRED TO LOW WATER DATUM (LWD) WIDTH OF ENTRANCE CHANNEL INCREASES AS BREAKWATER SPURS ARE REMOVED

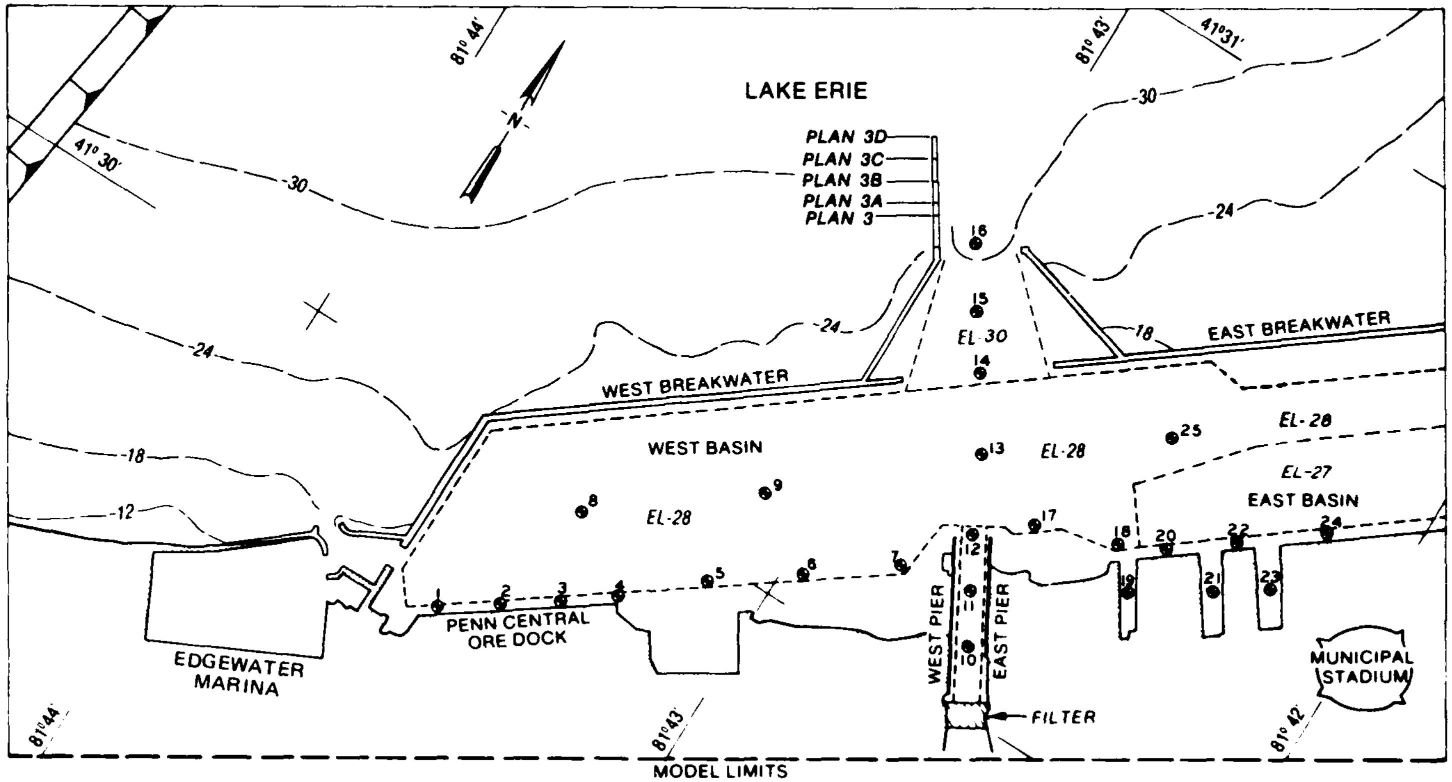
| PLAN NO | BREAKWATER REMOVED, FT | |
|---|---|---|
| | EAST SPUR | WEST SPUR |
| 2 | 100 | 200 |
| 2A | 200 | 300 |
| 2B | 300 | 400 |
| 2C | 400 | 500 |

**ELEMENTS OF FAIR-WEATHER PLANS 2-2C**

SCALES

PROTOTYPE 1000 0 1000 2000 FT

MODEL 10 0 10 20 FT




LEGEND

⊗1 WAVE GAGE LOCATION AND NUMBER

NOTE CONTOURS AND ELEVATION ARE SHOWN IN FEET REFERRED TO LOW WATER DATUM (LWD)

| PLAN NO. | NEW BREAKWATER LENGTH, FT | |
|---|---|---|
| | EAST | WEST |
| 3 | 0 | 300 |
| 3A | 0 | 400 |
| 3B | 0 | 600 |
| 3C | 0 | 800 |
| 3D | 0 | 1000 |

# ELEMENTS OF FAIR-WEATHER PLANS 3-3D

SCALES

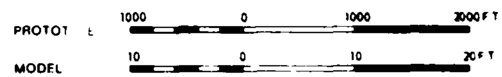
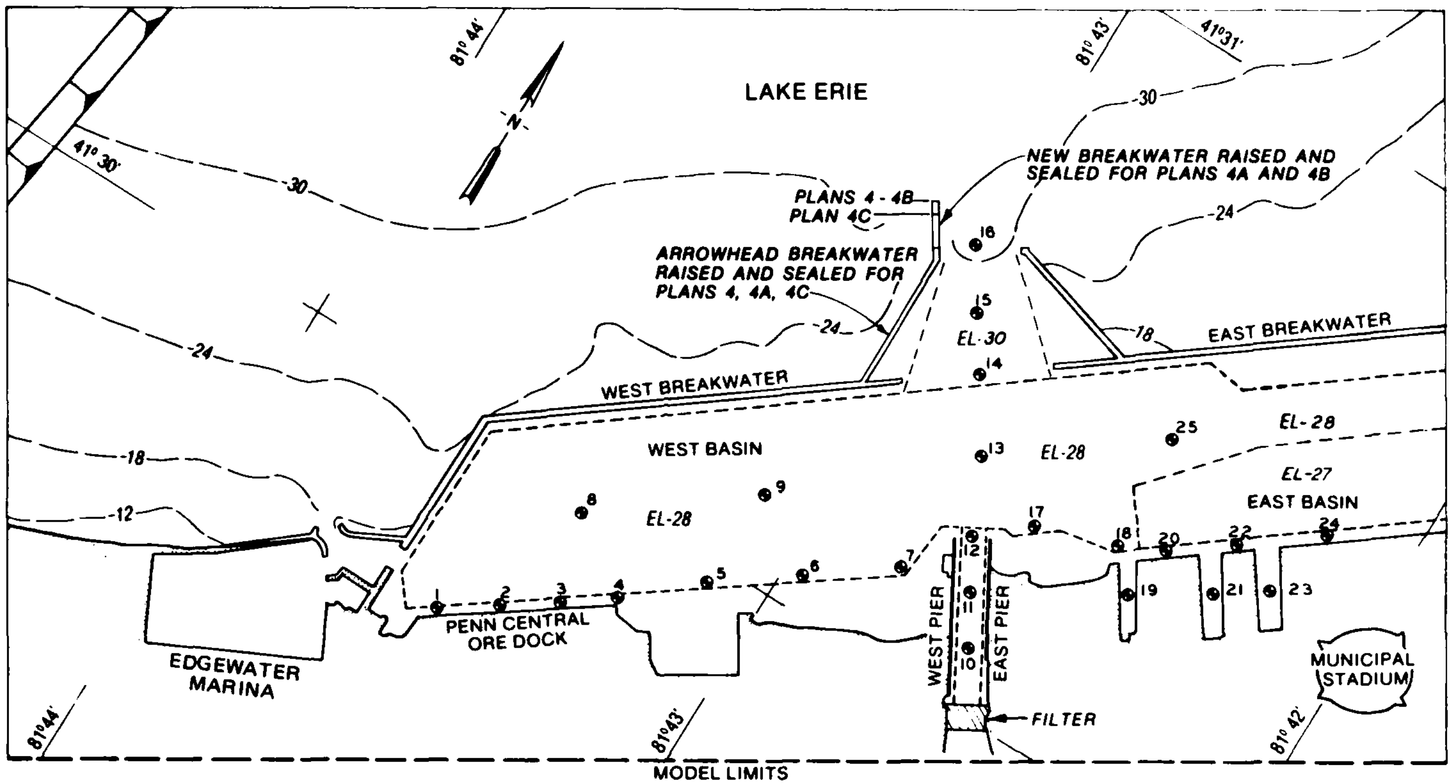



PLATE 4




LEGEND

⊕1 WAVE GAGE LOCATION AND NUMBER

NOTE CONTOURS AND ELEVATION ARE SHOWN IN FEET REFERRED TO LOW WATER DATUM (LWD)

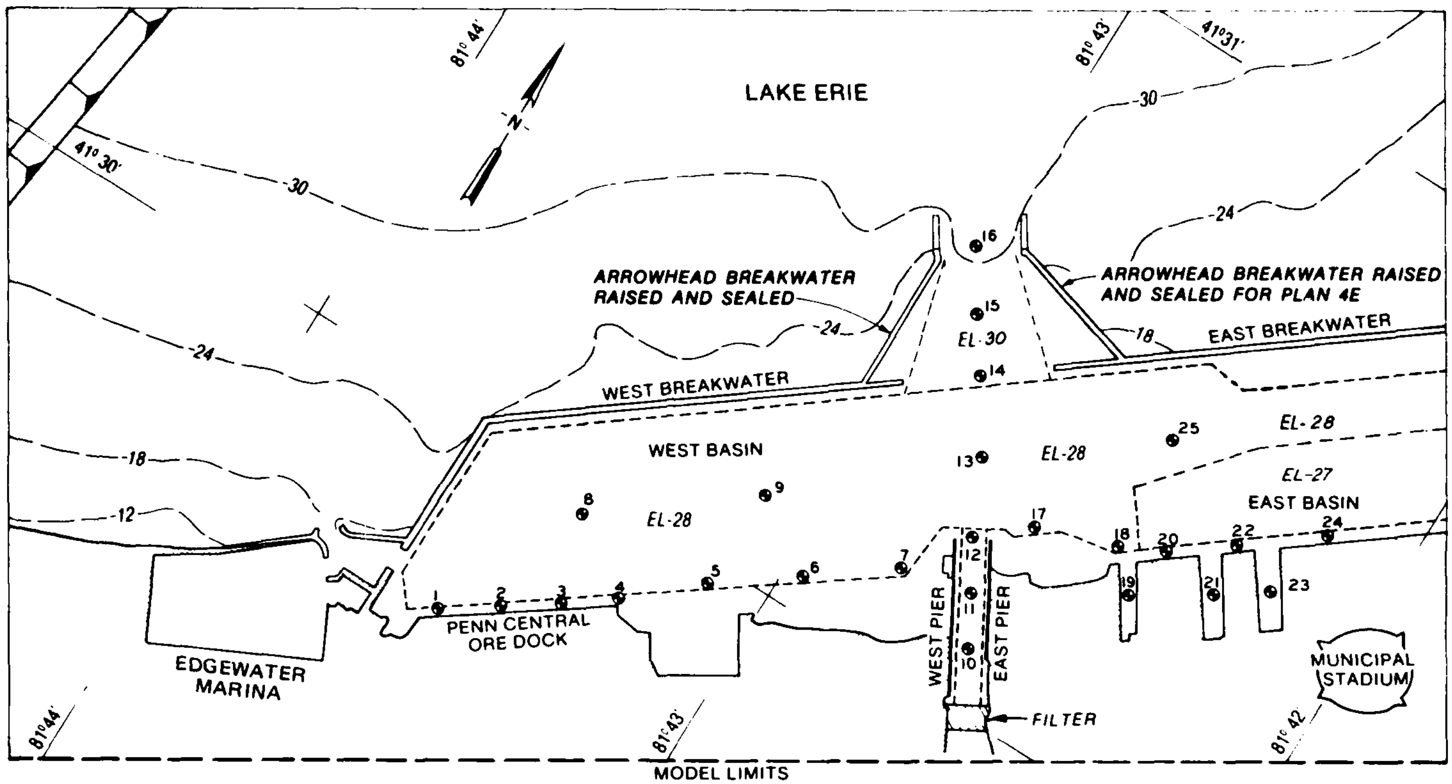
| PLAN | NEW BREAKWATER LENGTH, FT | |
|---|---|---|
| NO. | EAST | WEST |
| 4 | 0 | 400 |
| 4A | 0 | 400 |
| 4B | 0 | 400 |
| 4C | 0 | 300 |

**ELEMENTS OF FAIR-WEATHER PLANS 4-4C**

SCALES

PROTOTYPE 1000 0 1000 2000 FT

MODEL 10 0 10 20 FT




LEGEND

⊕1 WAVE GAGE LOCATION AND NUMBER

NOTE CONTOURS AND ELEVATION ARE SHOWN IN FEET REFERRED TO LOW WATER DATUM (LWD)

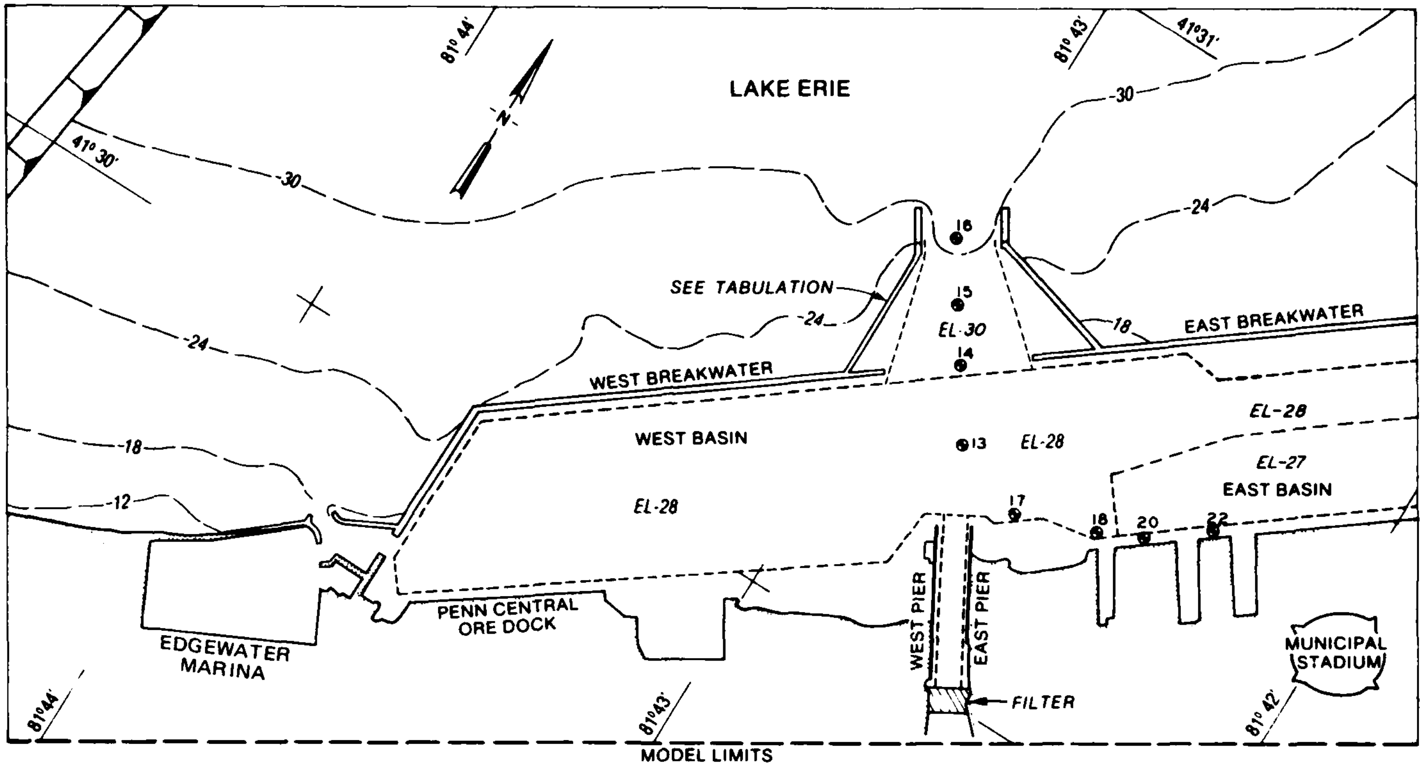
| PLAN NO. | NEW BREAKWATER LENGTH, FT | |
|---|---|---|
| | EAST | WEST |
| 4D | 300 | 300 |
| 4E | 300 | 300 |

# ELEMENTS OF FAIR-WEATHER PLANS 4D AND 4E

SCALES

PROTOTYPE 1000 0 1000 2000 FT

MODEL 10 0 10 20 FT




LEGEND

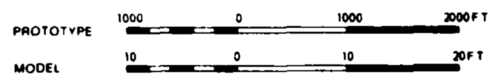
⊕13 WAVE GAGE LOCATION AND NUMBER

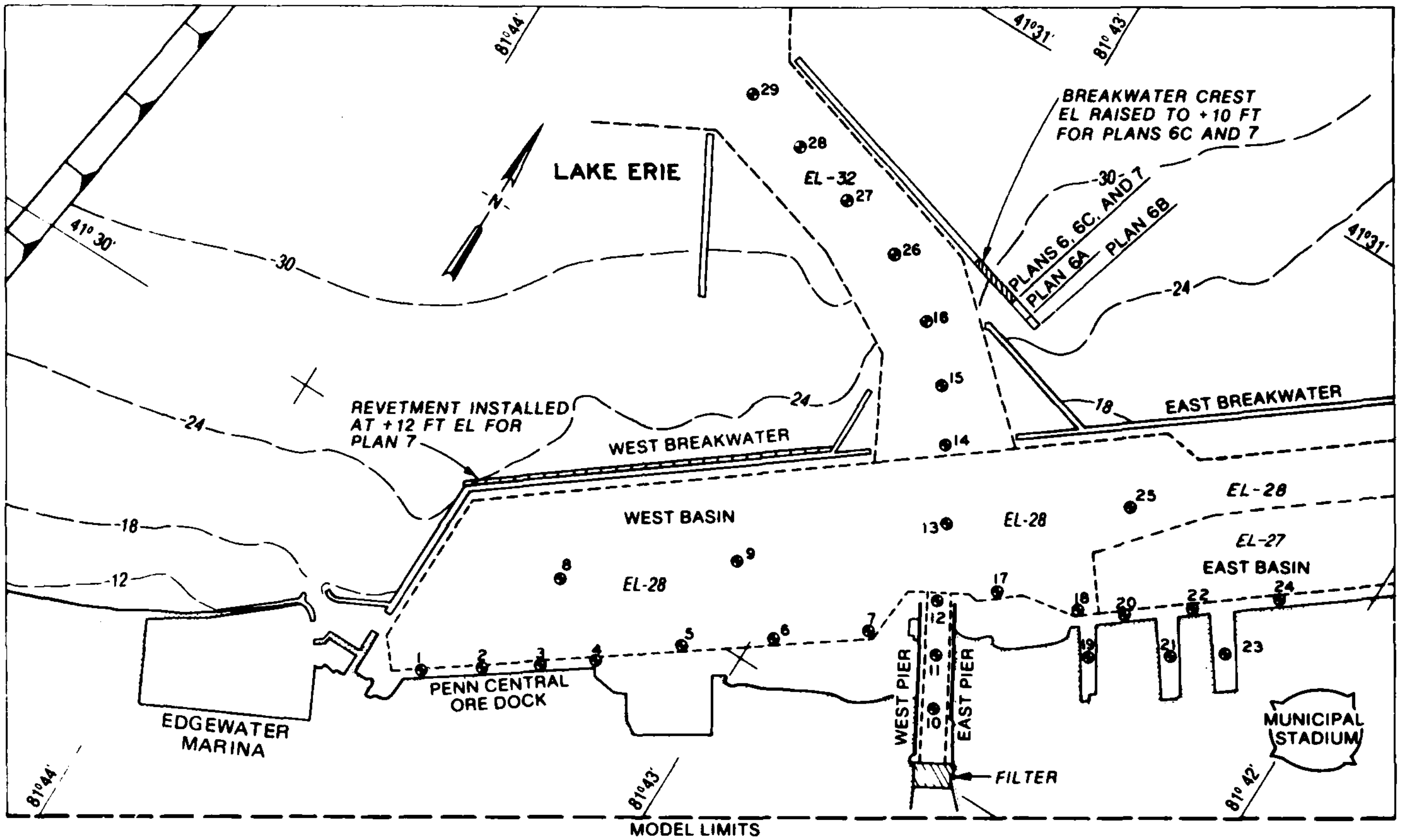
NOTE CONTOURS AND ELEVATION ARE SHOWN IN FEET REFERRED TO LOW WATER DATUM (LWD)

| PLAN | WEST ARROWHEAD BREAKWATER | | |
|---|---|---|---|
| NO. | CREST EL. FT | SEALED | UNSEALED |
| 5 | +16 | X | |
| 5A | +14 | X | |
| 5B | +12 | X | |
| 5C | +10 | X | |
| 5D | + 8 | X | |
| 5E | +10 | | X |
| 5F | +12 | | X |
| 5G | +14 | | X |

## ELEMENTS OF FAIR-WEATHER PLANS 5-5G

SCALES






## ELEMENTS OF SEVERE-WEATHER PLANS 6-6C AND 7

**LEGEND**

⊕1 WAVE GAGE LOCATION AND NUMBER

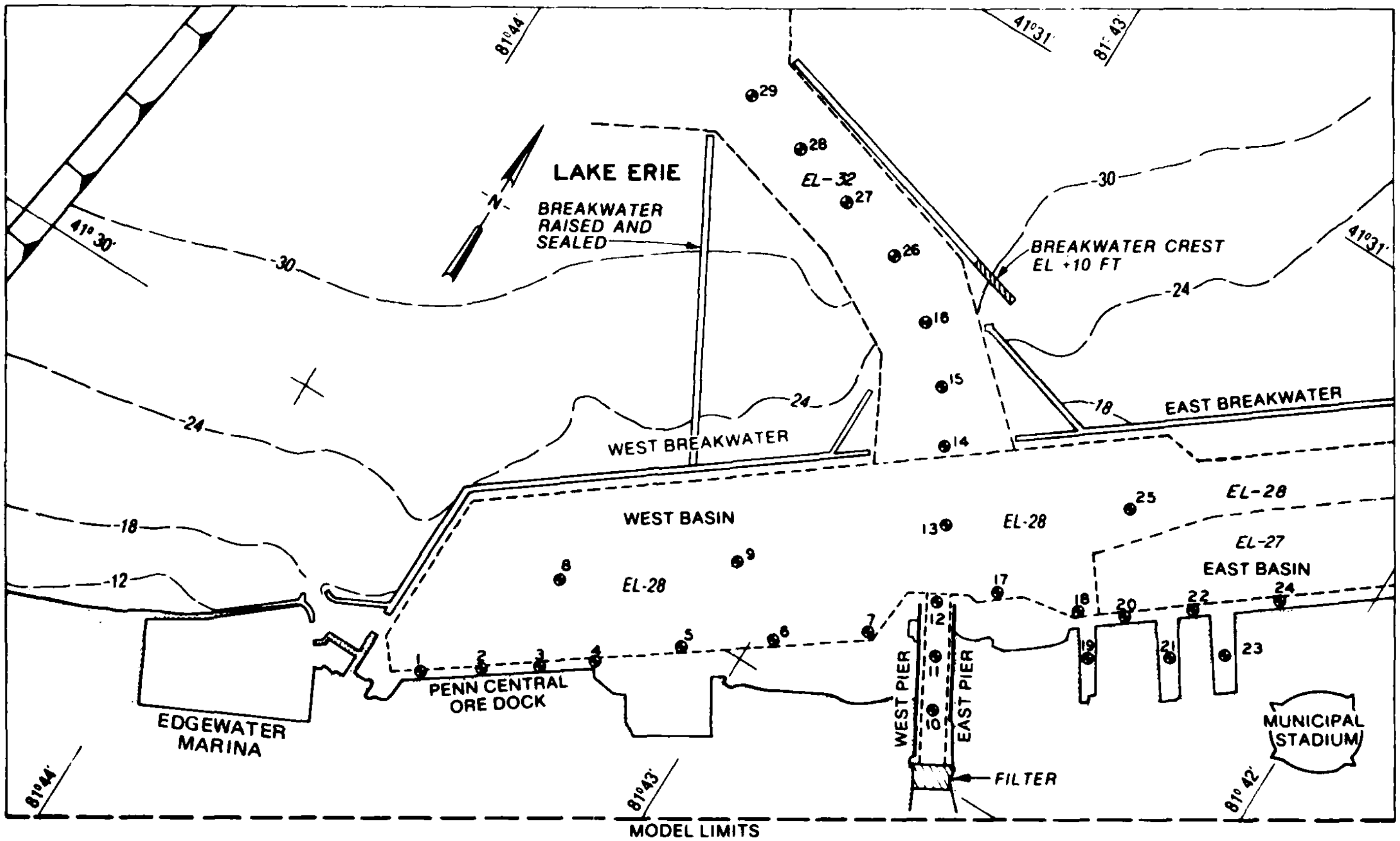
NOTE CONTOURS AND ELEVATION ARE SHOWN IN FEET REFERRED TO LOW WATER DATUM (LWD)

SCALES

PROTOTYPE 1000 0 1000 2000 FT

MODEL 10 0 10 20 FT

PLATE 8




LEGEND

● 1 WAVE GAGE LOCATION AND NUMBER

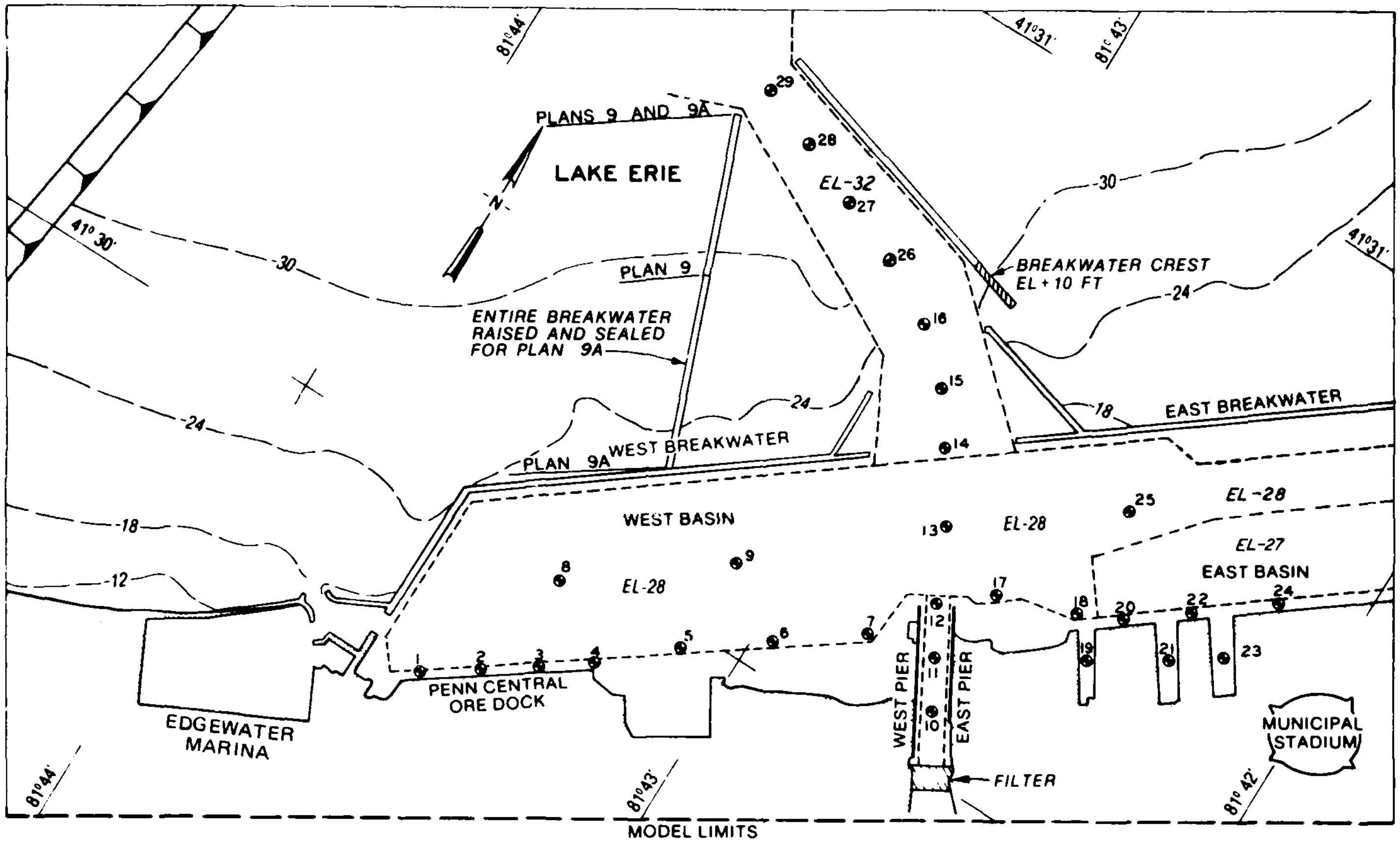
NOTE CONTOURS AND ELEVATION ARE SHOWN IN FEET REFERRED TO LOW WATER DATUM (LWD)

## ELEMENTS OF SEVERE-WEATHER PLAN 8

SCALES

PROTOTYPE 1000 0 1000 2000 FT

MODEL 10 0 10 20 FT




LEGEND

⊕1 WAVE GAGE LOCATION AND NUMBER

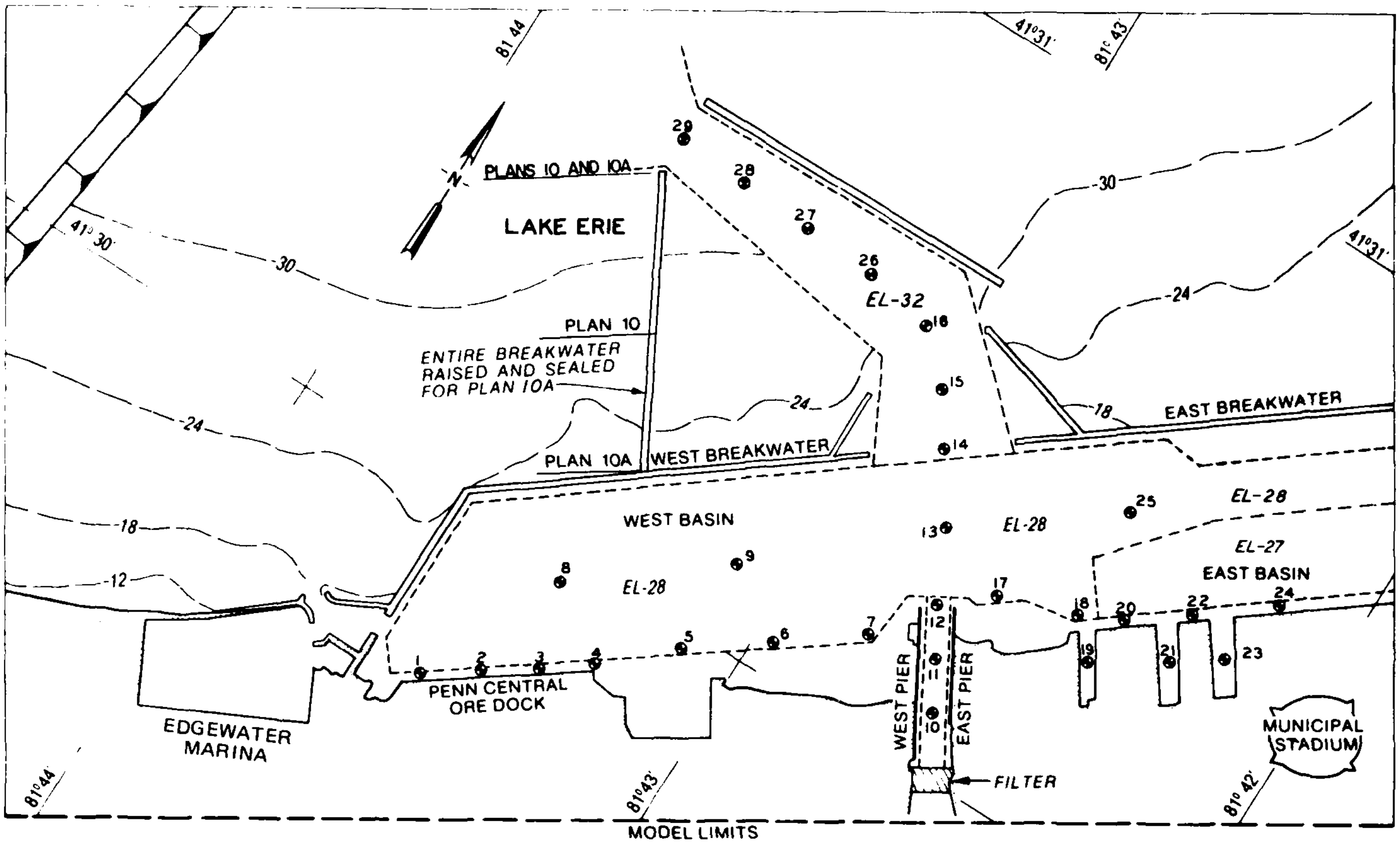
NOTE CONTOURS AND ELEVATION ARE SHOWN IN FEET REFERRED TO LOW WATER DATUM (LWD)

**ELEMENTS OF SEVERE-WEATHER PLANS 9 AND 9A**

SCALES

PROTOTYPE 1000 0 1000 2000 FT

MODEL 10 0 10 20 FT




LEGEND

⊕1 WAVE GAGE LOCATION AND NUMBER

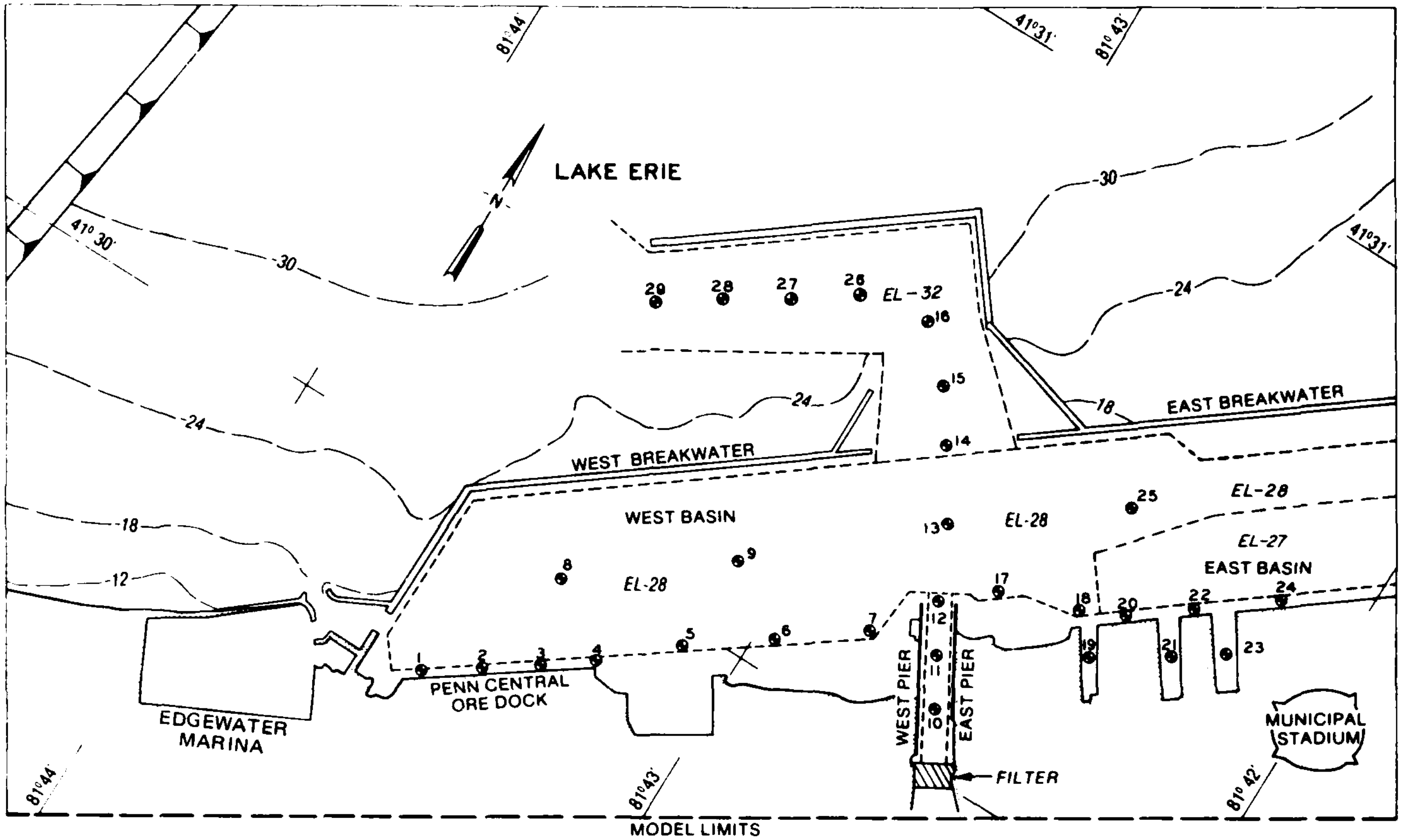
NOTE CONTOURS AND ELEVATION ARE SHOWN IN FEET REFERRED TO LOW WATER DATUM (LWD)

SCALES

PROTOTYPE 1000 0 1000 2000 FT

MODEL 10 0 10 20 FT

ELEMENTS OF
SEVERE-WEATHER PLANS 10 AND 10A




LEGEND

WAVE GAGE LOCATION AND NUMBER

NOTE CONTOURS AND ELEVATION ARE SHOWN IN FEET REFERRED TO LOW WATER DATUM (LWD)

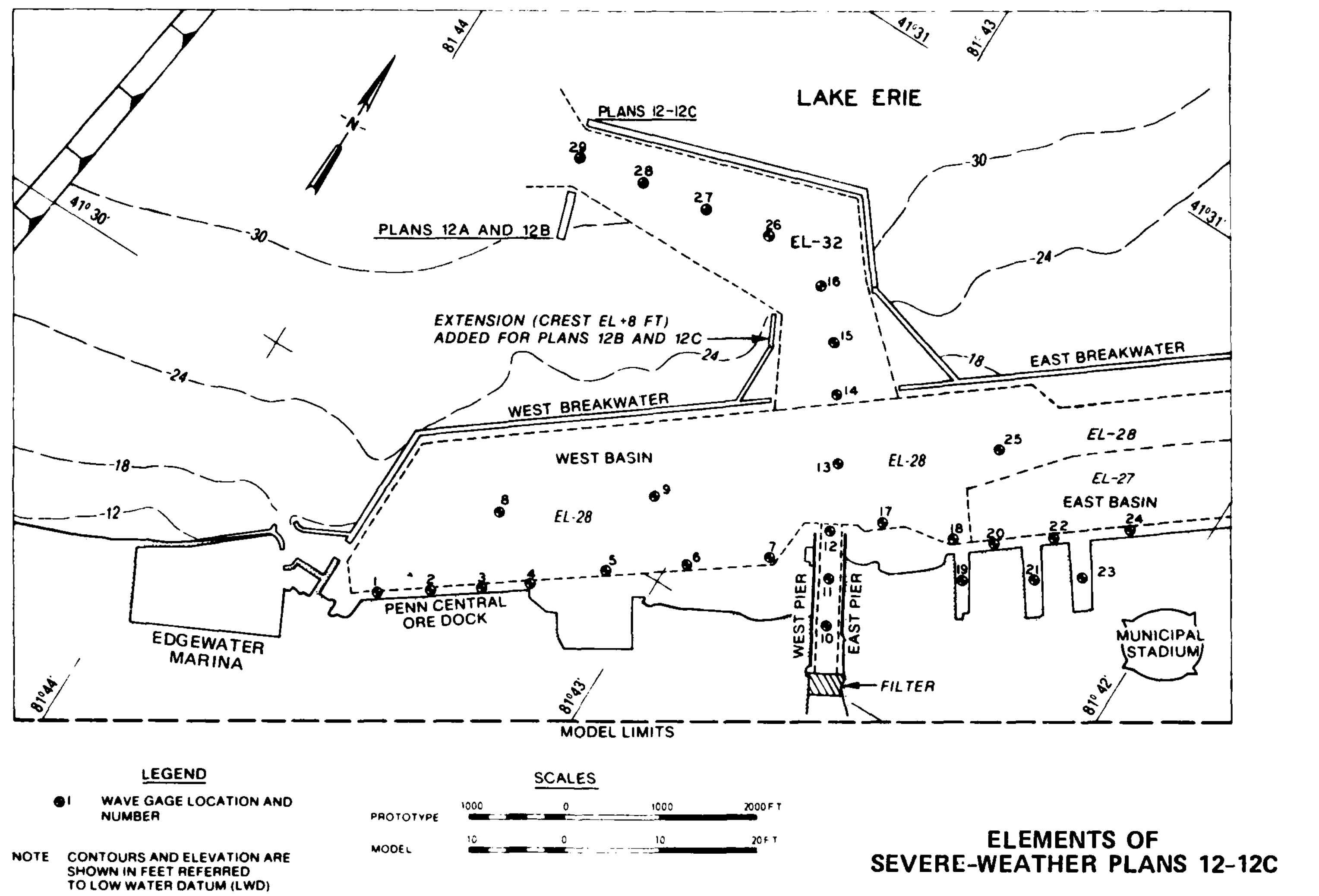
SCALES

PROTOTYPE 1000 0 1000 2000 FT

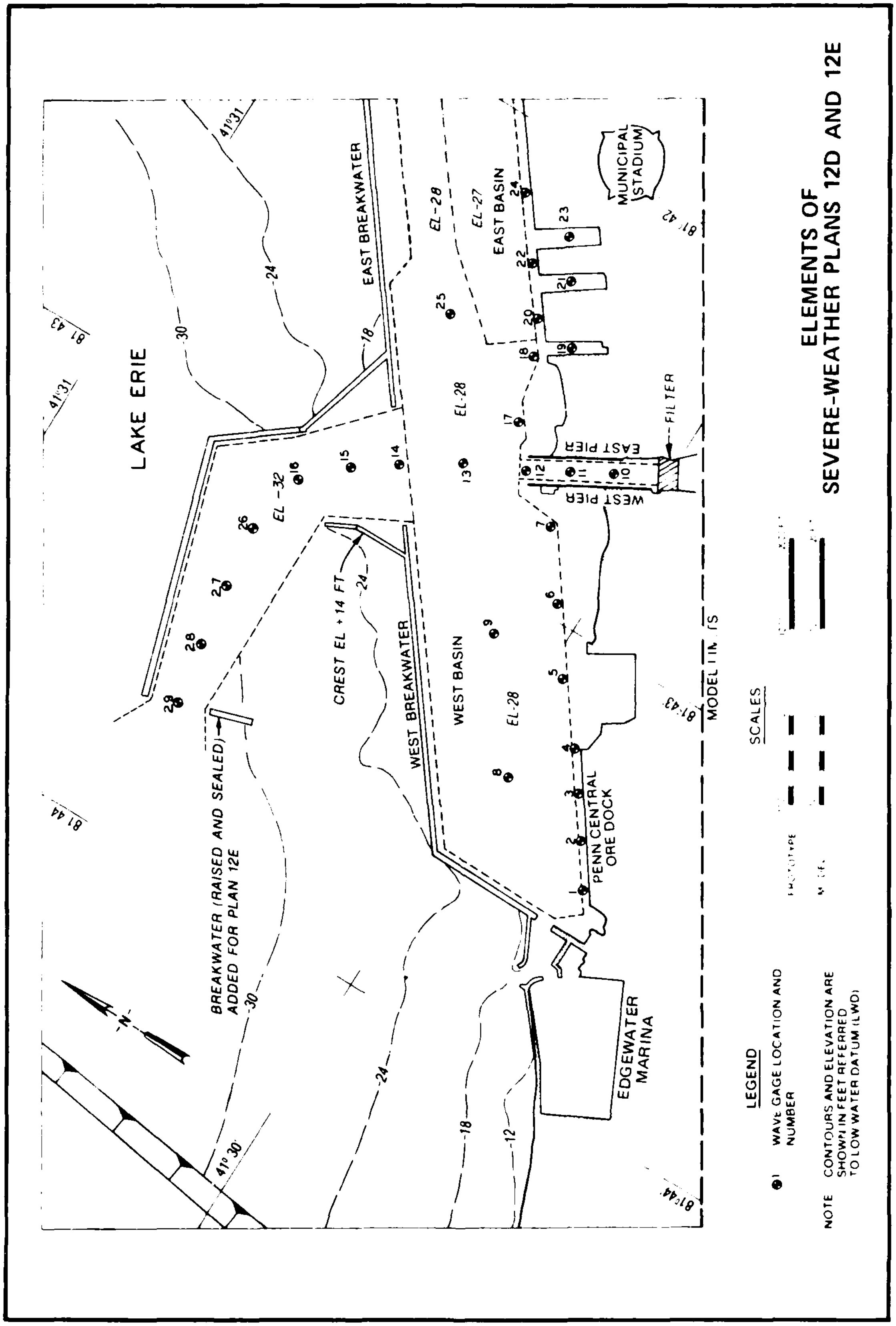
MODEL 10 0 10 20 FT

**ELEMENTS OF SEVERE-WEATHER PLAN 11**

PLATE 12

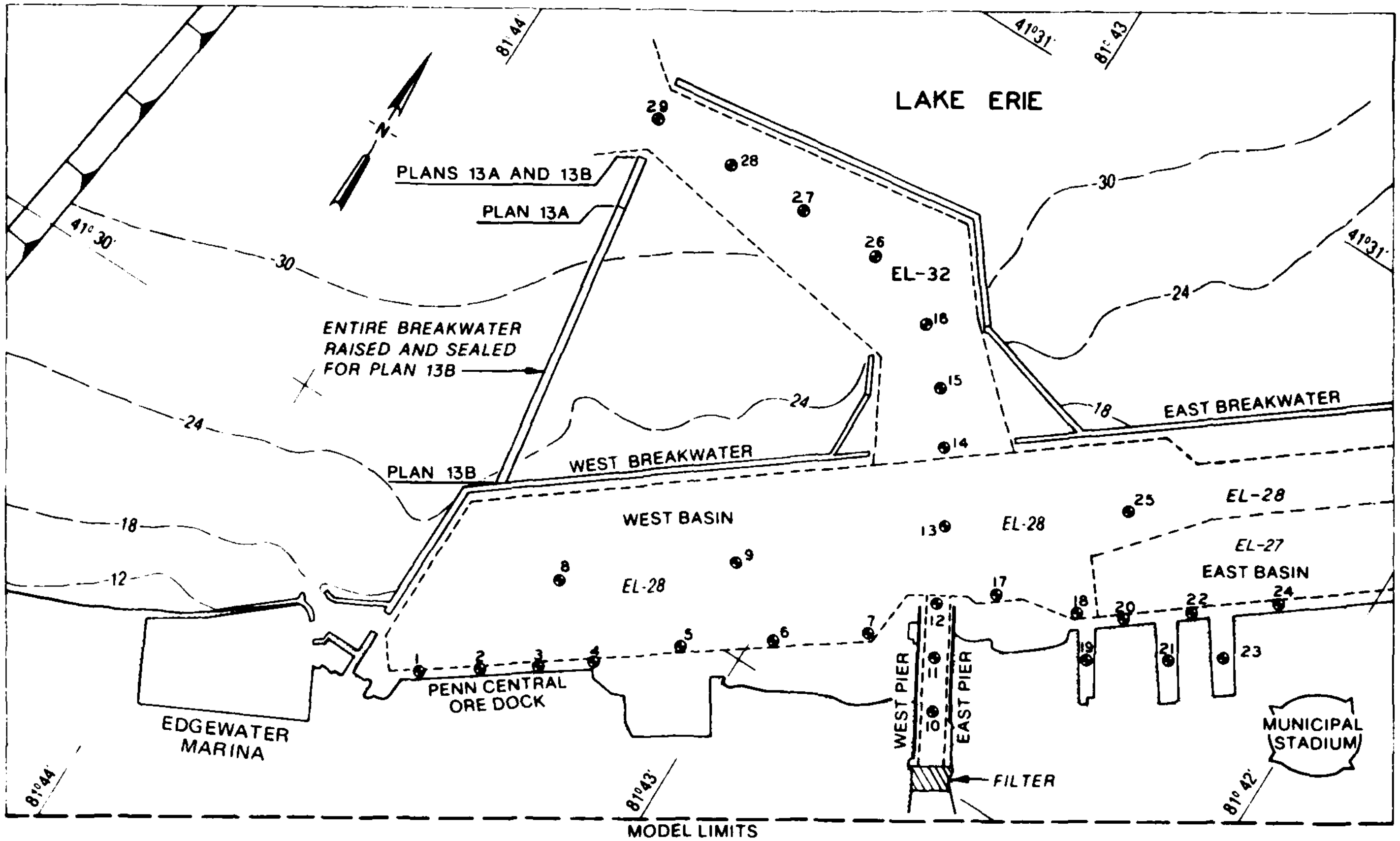



ELEMENTS OF
SEVERE-WEATHER PLANS 12-12C




ELEMENTS OF SEVERE-WEATHER PLANS 12D AND 12E

PLATE 14




LEGEND

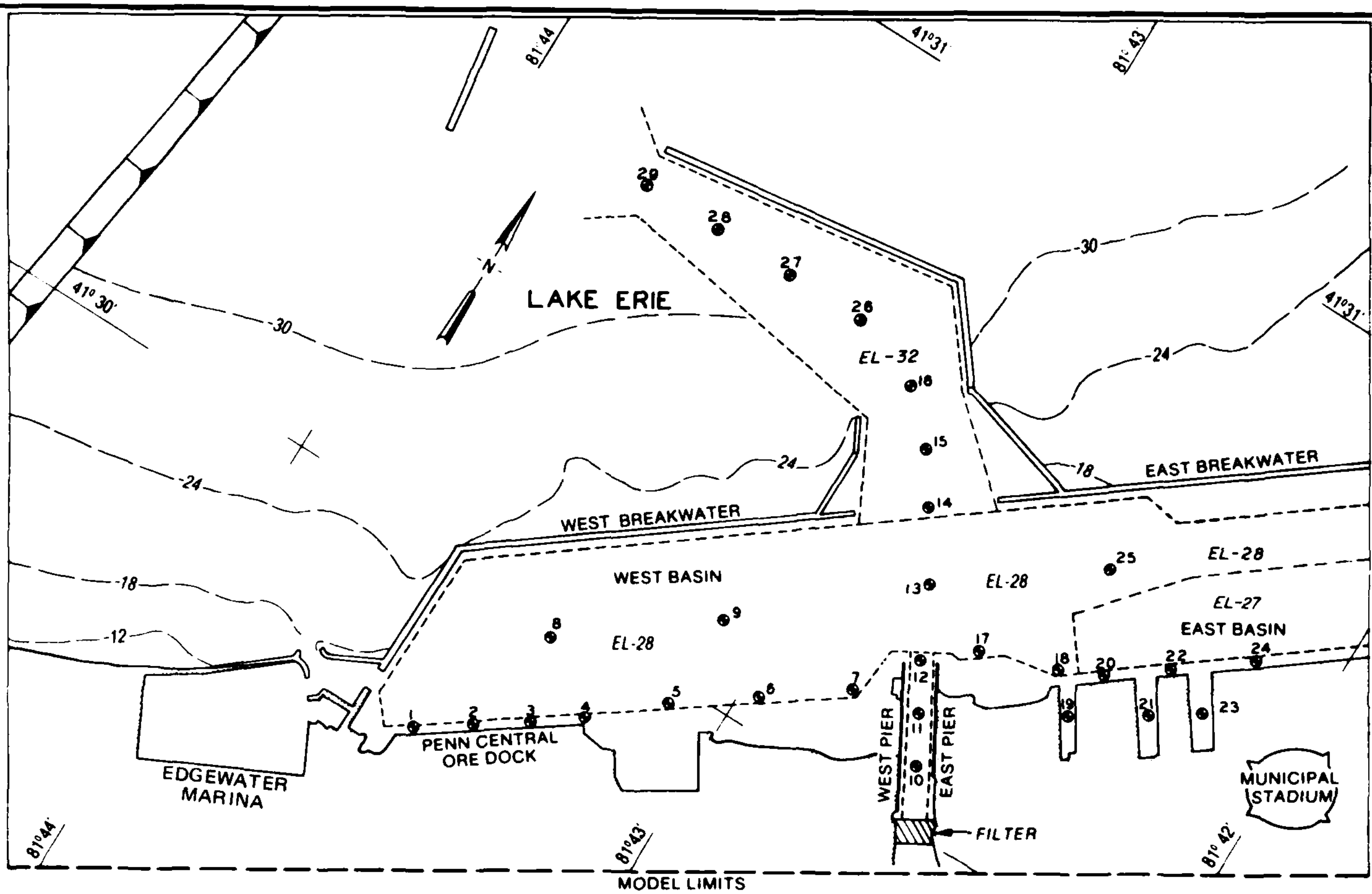
⊛1 WAVE GAGE LOCATION AND NUMBER

NOTE CONTOURS AND ELEVATION ARE SHOWN IN FEET REFERRED TO LOW WATER DATUM (LWD)

SCALES

| | | | | |
|---|---|---|---|---|
| PROTOTYPE | 1000 | 0 | 1000 | 2000 FT |
| MODEL | 10 | 0 | 10 | 20 FT |

ELEMENTS OF
SEVERE-WEATHER PLANS 13-13B




LEGEND

● 1 WAVE GAGE LOCATION AND NUMBER

NOTE CONTOURS AND ELEVATION ARE SHOWN IN FEET REFERRED TO LOW WATER DATUM (LWD)

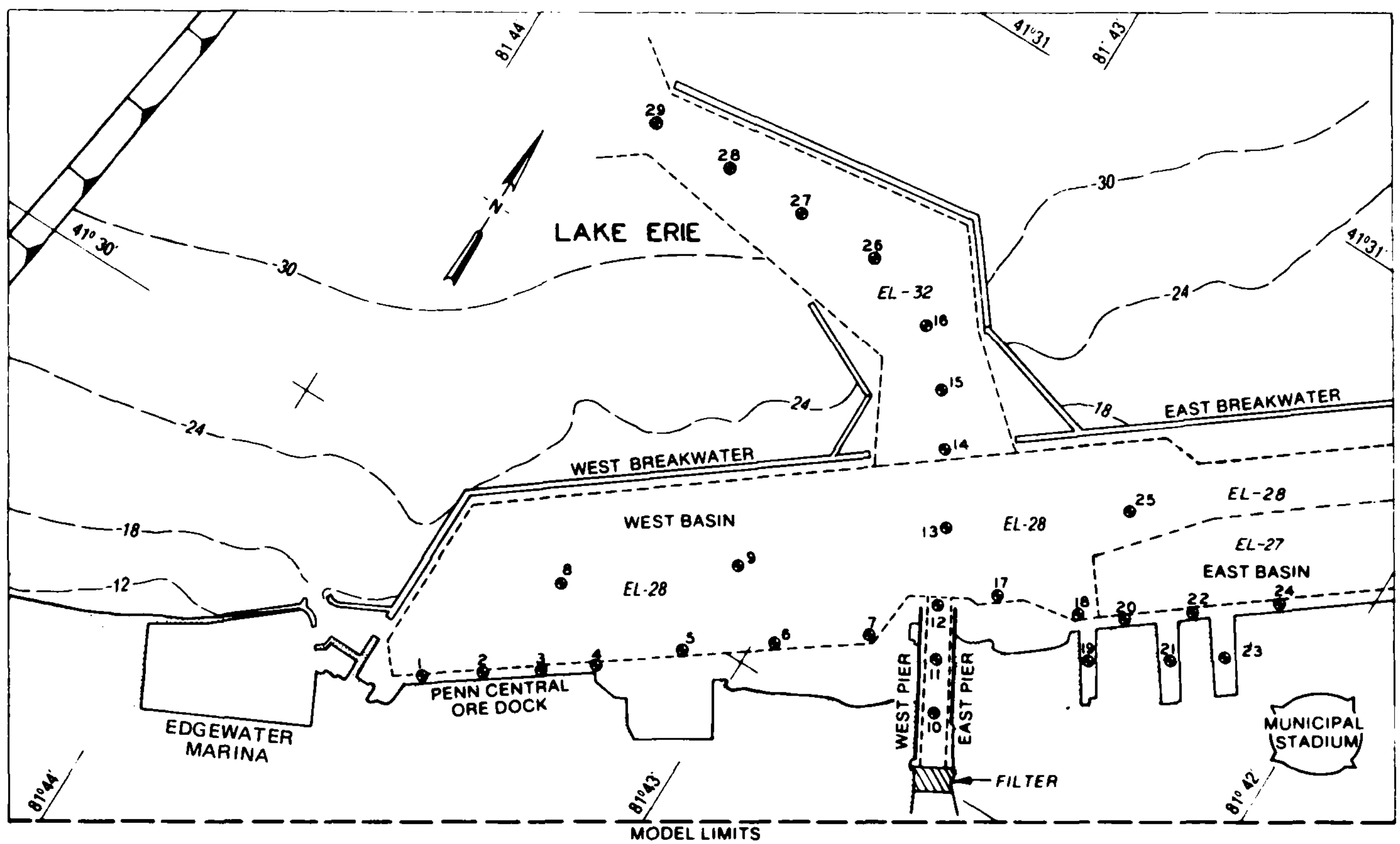
SCALES

PROTOTYPE 1000 0 1000 2000 FT

MODEL 10 0 10 20 FT

**ELEMENTS OF SEVERE-WEATHER PLAN 13C**

PLATE 16




LEGEND

● 1 WAVE GAGE LOCATION AND NUMBER

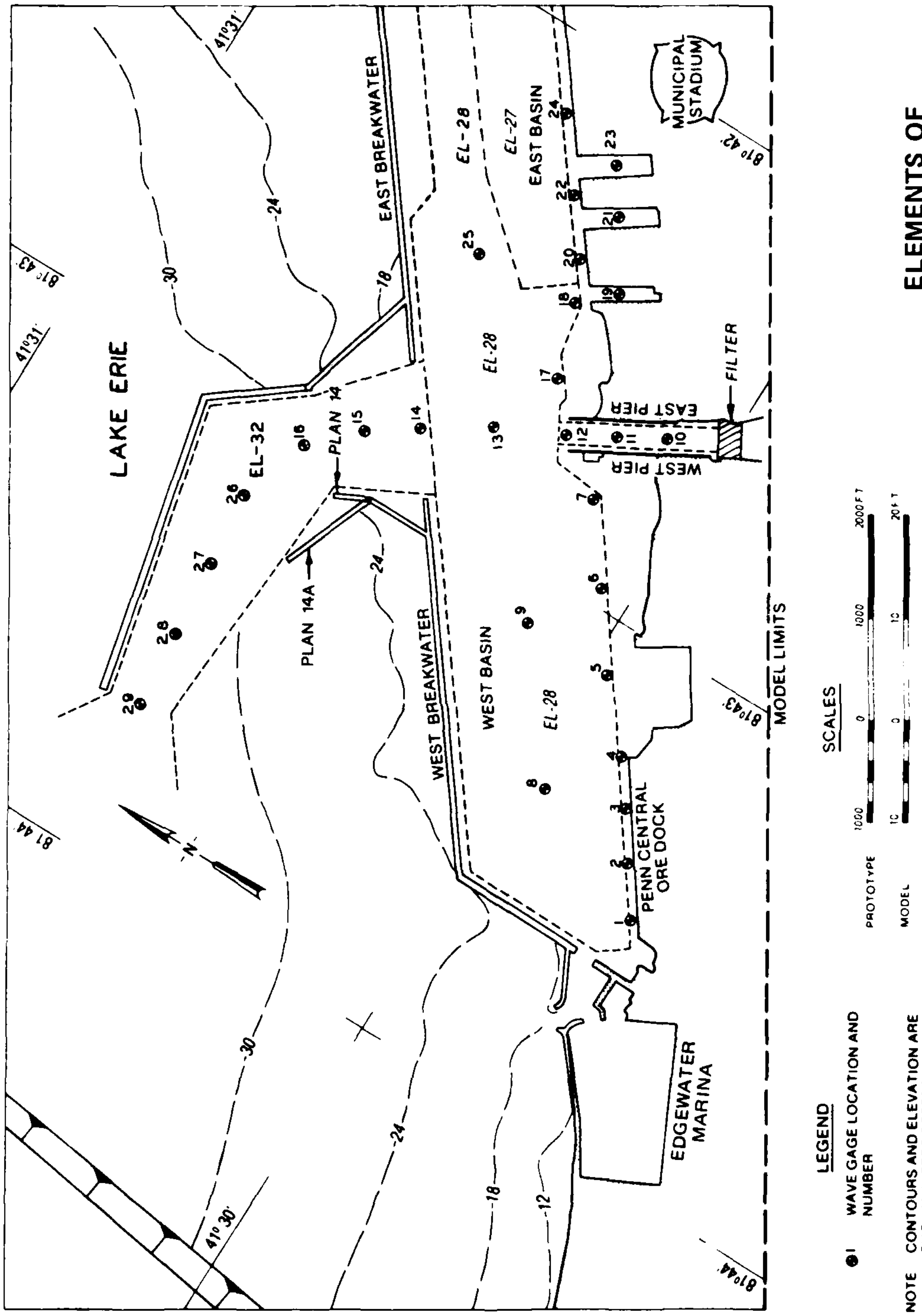
NOTE CONTOURS AND ELEVATION ARE SHOWN IN FEET REFERRED TO LOW WATER DATUM (LWD)

SCALES

PROTOTYPE 1000 0 1000 2000 FT

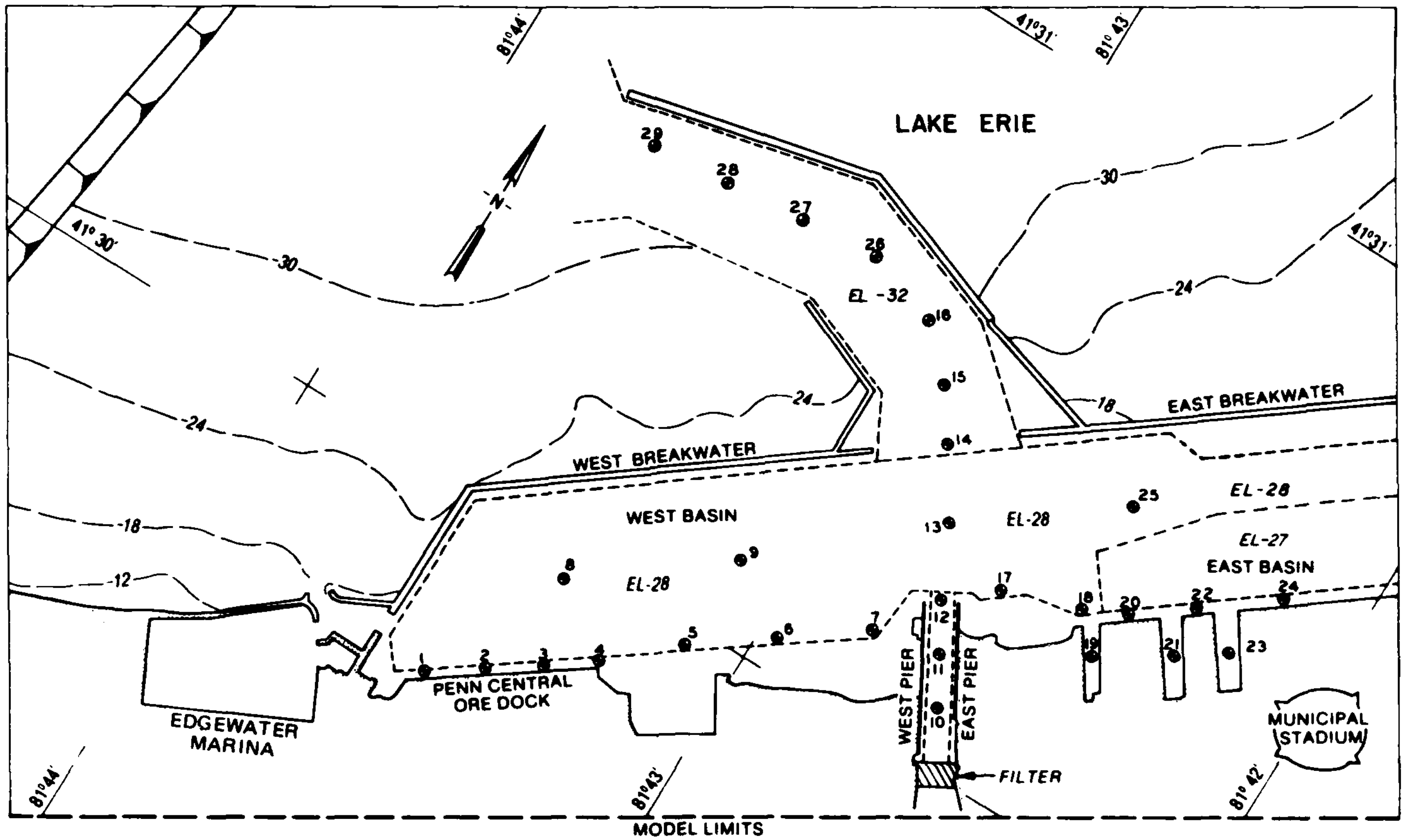
MODEL 10 0 10 20 FT

**ELEMENTS OF SEVERE-WEATHER PLAN 13D**




ELEMENTS OF SEVERE-WEATHER PLANS 14 AND 14A

PLATE 18




LEGEND

● 1 WAVE GAGE LOCATION AND NUMBER

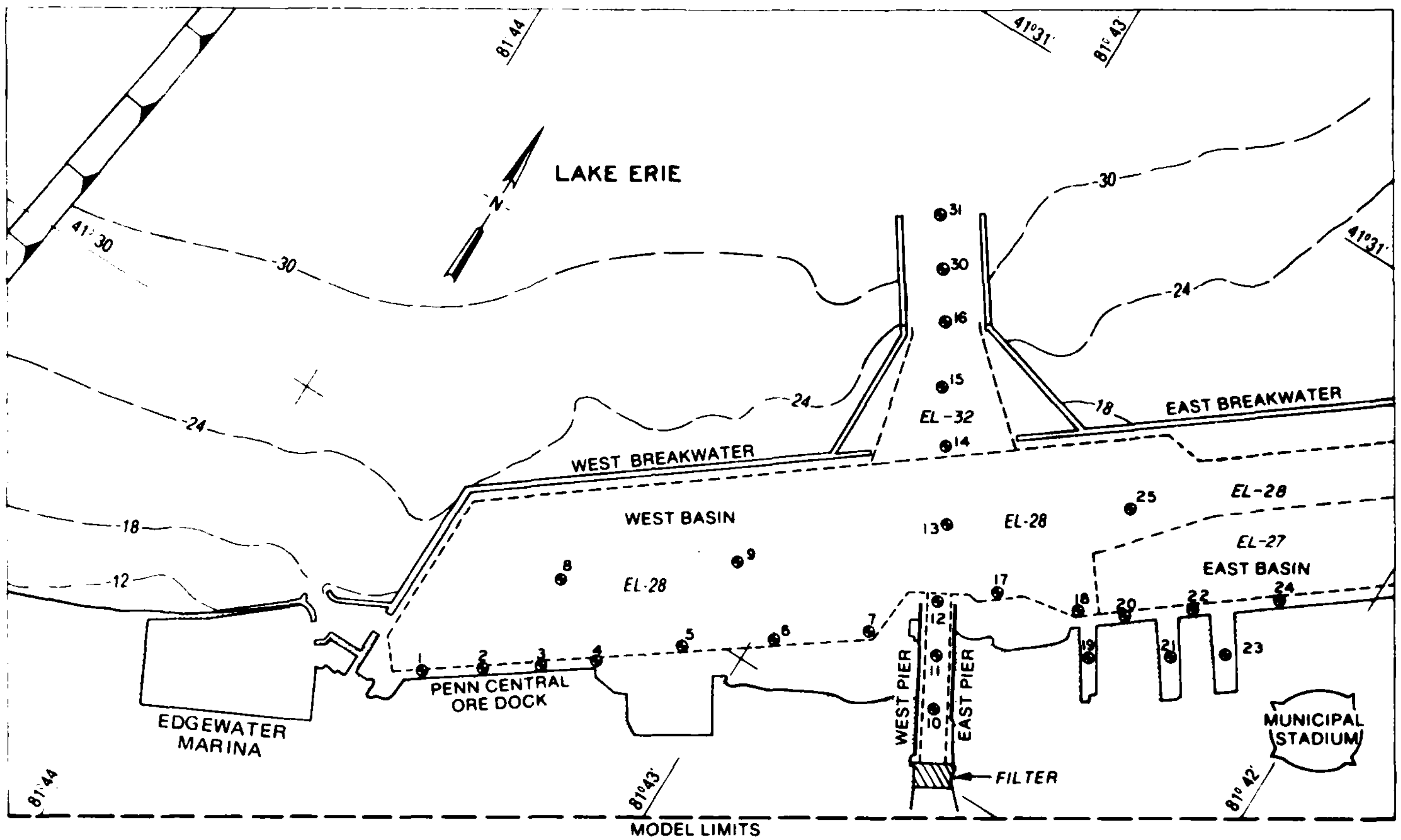
NOTE CONTOURS AND ELEVATION ARE SHOWN IN FEET REFERRED TO LOW WATER DATUM (LWD)

SCALES

PROTOTYPE 1000 0 1000 2000 FT

MODEL 10 0 10 20 FT

ELEMENTS OF
SEVERE-WEATHER PLAN 15




LEGEND

⊕1 WAVE GAGE LOCATION AND NUMBER

NOTE CONTOURS AND ELEVATION ARE SHOWN IN FEET REFERRED TO LOW WATER DATUM (LWD)

SCALES

PROTOTYPE 1000 0 1000 2000 FT

MODEL 10 0 10 20 FT

## ELEMENTS OF SEVERE-WEATHER PLAN 16

# APPENDIX A: WAVE-REFRACTION ANALYSIS, FOR CLEVELAND HARBOR

1. Prior to the hydraulic model investigation of Cleveland Harbor, a wave-refraction analysis was conducted at the U. S. Army Engineer Waterways Experiment Station (WES) to determine the shallow-water wave height and the refracted wave direction at the model wave generator pit for representative wave periods from the critical directions of deepwater wave approach. This analysis was conducted using a linear wave-refraction theory originally developed at Stanford University by Dobson (1967)* and modified by WES (Whalin 1971). All computations and plotting were done using an Electronic Associates, Inc. (EAI) Pacer 100 minicomputer and Versatec electrostatic plotter at WES.

2. In this analysis, the effects of both reflection and diffraction are neglected. These assumptions are valid except in convergence areas where caustics occur and linear theory does not apply. Therefore, the major assumption in determining the wave height at any point on a wave orthogonal, within the limits of the linear theory, is that no energy is transmitted perpendicular to the orthogonal along the wave crest, in which case the height at any given point is given by

$$H = H_o K_s K_r$$

where

$H_o$ = wave height in deep water

$K_s$ = shoaling coefficient

$K_r$ = refraction coefficient

This assumption has been shown to be reasonable for mild slopes which induce only gradual bending of the orthogonals. For areas of extreme refraction, failure to consider the flow of energy along the wave crests can lead to significant errors in the computed wave height. Since

* See references at the end of main text.

previous research at WES by Whalin (1971, 1972) has shown that wave energy will tend to flow along the wave crests in areas of energy concentration, a maximum refraction coefficient of 1.4 and a minimum refraction coefficient of 0.45 were selected as being reasonable values.

3. Refraction diagrams for Cleveland Harbor were produced from a rectangular depth grid (8.4 miles by 5.2 miles) which paralleled the shoreline in the vicinity of the project area and extended lakeward beyond the deepwater wave data gage location (Plate A1) from which wave characteristics were obtained (Resio and Vincent 1976a). Limits of the depth grid used are shown in Plate A1. The grid spacing was 400 ft and depths were taken from the latest lake survey charts. Storm conditions were represented by superimposing a water level of 4.0 ft on the depth grid.

4. Wave orthogonals were produced for 5-, 6-, 7-, 8-, 9-, and 10-sec waves from the west, west-northwest, northwest, north-northwest, north, and north-northeast. The plots obtained are shown in Plates A3-A38. Identification of various features shown on these plates are presented in Plate A2.

5. Refraction coefficients and shallow-water orthogonal directions obtained for the various wave periods from the six deepwater wave directions are presented in Table A1. These values represent an average of the orthogonals in the immediate vicinity of the harbor site (approximately the location of the wave generator in the model). Shoaling coefficients of 1.00, 0.99, 0.97, 0.94, C.92, and 0.91 for 5-, 6-, 7-, 8-, 9-, and 10-sec wave periods, respectively, were computed for a 94-ft water depth corresponding to the simulated depth at the model wave generator (includes 90-ft depth in pit with 4-ft storm conditions superimposed). The wave-height adjustment factor is obtained by multiplying $K_r$ times $K_s$ and can be applied to any deepwater wave height to obtain the corresponding shallow-water value.

6. Based on the refracted directions secured at the approximate wave machine locations for each wave period, six wave generator positions were defined for model testing representing the various deepwater directions. The following tabulation shows the deepwater directions and

the corresponding shallow-water test directions.

| Deepwater Direction, Azimuth, deg | | Corresponding Shallow-Water Test Direction Azimuth, deg |
|---|---|---|
| West | 270 | 279 |
| NWN | 292.5 | 300 |
| NW | 315 | 316 |
| NNW | 337.5 | 336 |
| North | 360 | 357 |
| NNE | 22.5 | 17 |

Table A1

Summary of Refraction and Shoaling Analysis for Cleveland Harbor

| Deepwater Direction, deg | Wave Period sec | Shallow-water Azimuth deg | Refraction* Coefficient | Shoaling** Coefficient | Wave-Height Adjustment Factor |
|---|---|---|---|---|---|
| West (270) | 5 | 274.7 | 0.91 | 1.00 | 0.91 |
| | 6 | 278.6 | 0.84 | 0.99 | 0.83 |
| | 7 | 278.8 | 0.81 | 0.97 | 0.79 |
| | 8 | 280.2 | 0.78 | 0.94 | 0.73 |
| | 9 | 281.5 | 0.77 | 0.92 | 0.71 |
| | 10 | 282.9 | 0.74 | 0.91 | 0.67 |
| WNW (292.5) | 5 | 296.1 | 0.97 | 1.00 | 0.97 |
| | 6 | 297.5 | 0.95 | 0.99 | 0.94 |
| | 7 | 299.8 | 0.91 | 0.97 | 0.88 |
| | 8 | 300.8 | 0.90 | 0.94 | 0.85 |
| | 9 | 301.5 | 0.90 | 0.92 | 0.83 |
| | 10 | 302.2 | 0.90 | 0.91 | 0.82 |
| NW (315) | 5 | 315.2 | 1.02 | 1.00 | 1.02 |
| | 6 | 315.6 | 1.01 | 0.99 | 1.00 |
| | 7 | 315.5 | 1.00 | 0.97 | 0.97 |
| | 8 | 316.2 | 0.98 | 0.94 | 0.92 |
| | 9 | 316.1 | 0.97 | 0.92 | 0.89 |
| | 10 | 316.6 | 0.95 | 0.91 | 0.86 |
| NNW (337.5) | 5 | 337.2 | 1.02 | 1.00 | 1.02 |
| | 6 | 336.8 | 1.01 | 0.99 | 1.00 |
| | 7 | 336.4 | 0.99 | 0.97 | 0.96 |
| | 8 | 336.2 | 0.98 | 0.94 | 0.92 |
| | 9 | 335.9 | 0.97 | 0.92 | 0.89 |
| | 10 | 336.0 | 0.96 | 0.91 | 0.87 |
| North (360) | 5 | 358.8 | 1.03 | 1.00 | 1.03 |
| | 6 | 358.0 | 1.01 | 0.99 | 1.00 |
| | 7 | 356.7 | 0.99 | 0.97 | 0.96 |
| | 8 | 356.3 | 0.96 | 0.94 | 0.90 |
| | 9 | 355.4 | 0.96 | 0.92 | 0.88 |
| | 10 | 355.1 | 0.95 | 0.91 | 0.86 |
| NNE (22.5) | 5 | 20.6 | 0.99 | 1.00 | 0.99 |
| | 6 | 18.3 | 0.96 | 0.99 | 0.95 |
| | 7 | 16.9 | 0.92 | 0.97 | 0.89 |
| | 8 | 16.7 | 0.90 | 0.94 | 0.85 |
| | 9 | 15.1 | 0.89 | 0.92 | 0.82 |
| | 10 | 14.7 | 0.87 | 0.91 | 0.79 |

* At approximate locations of wave generator in model.

** At 90-ft depth (model pit elevation).

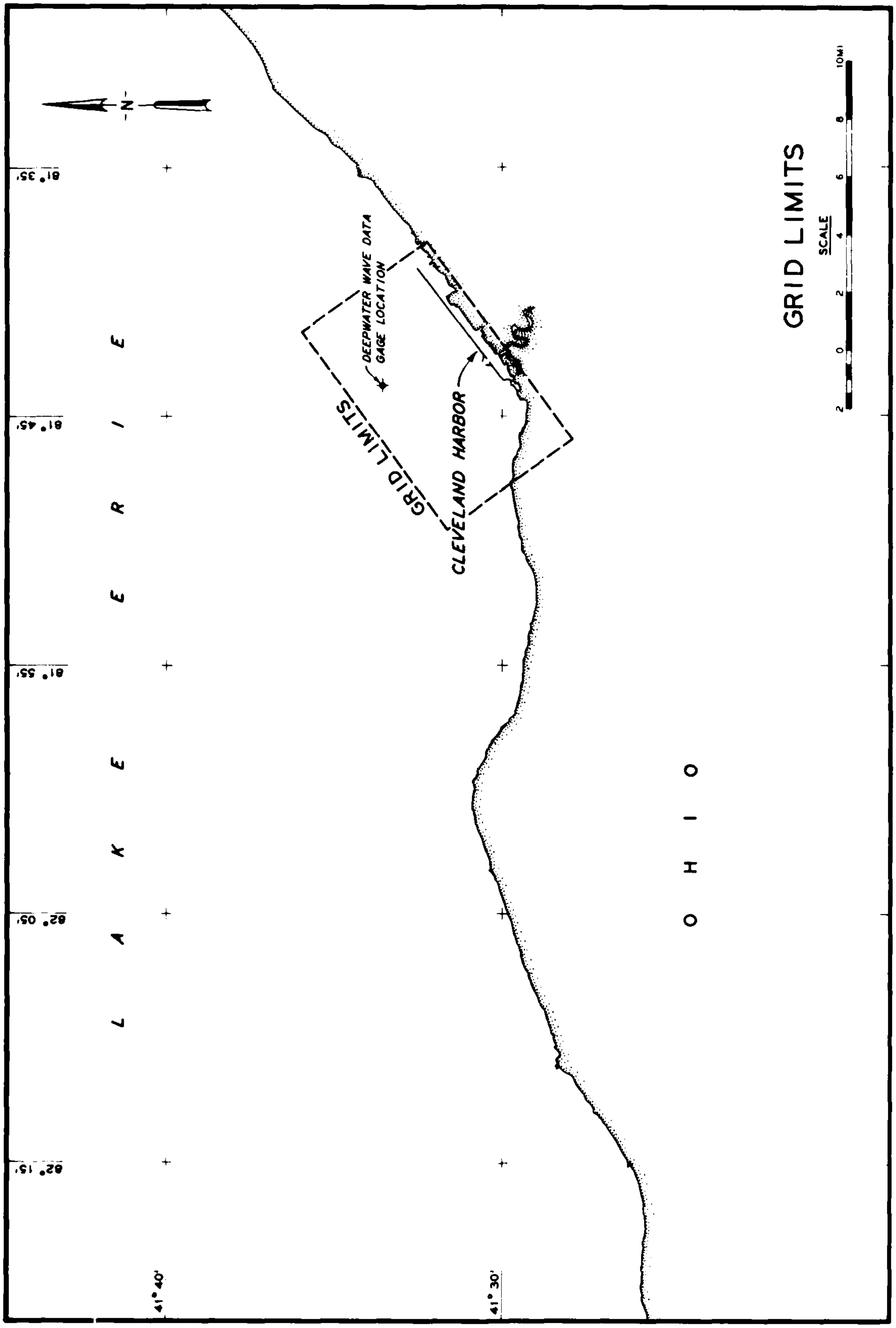
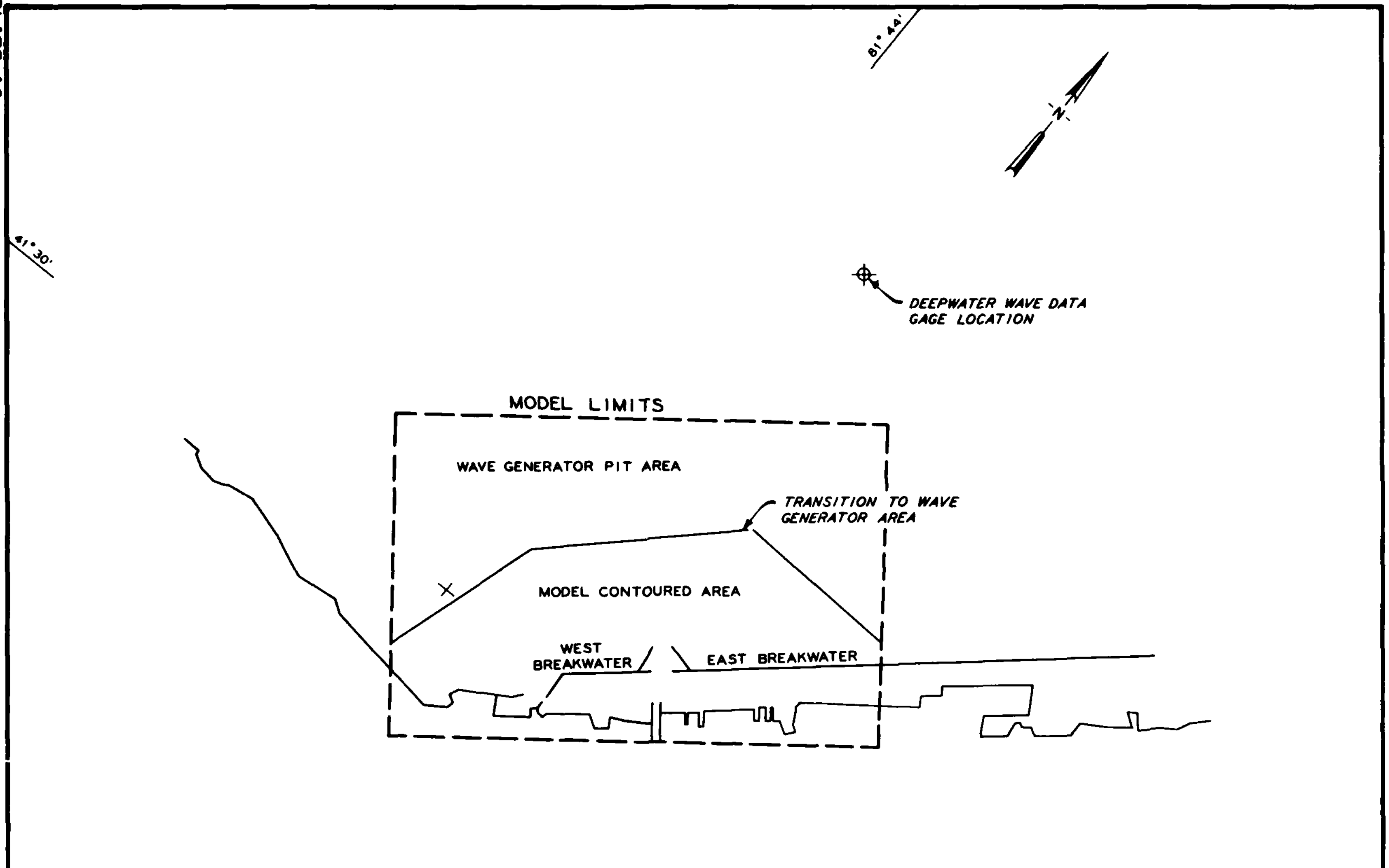

GRID LIMITS
SCALE
2 0 2 4 6 8 10MI
N
L A K E E R I E
O H I O
CLEVELAND HARBOR
GRID LIMITS
DEEPWATER WAVE DATA GAGE LOCATION
81° 35'
81° 45'
81° 55'
82° 05'
82° 15'
41° 40'
41° 30'

PLATE A1




IDENTIFICATION OF VARIOUS FEATURES

PLATE A2

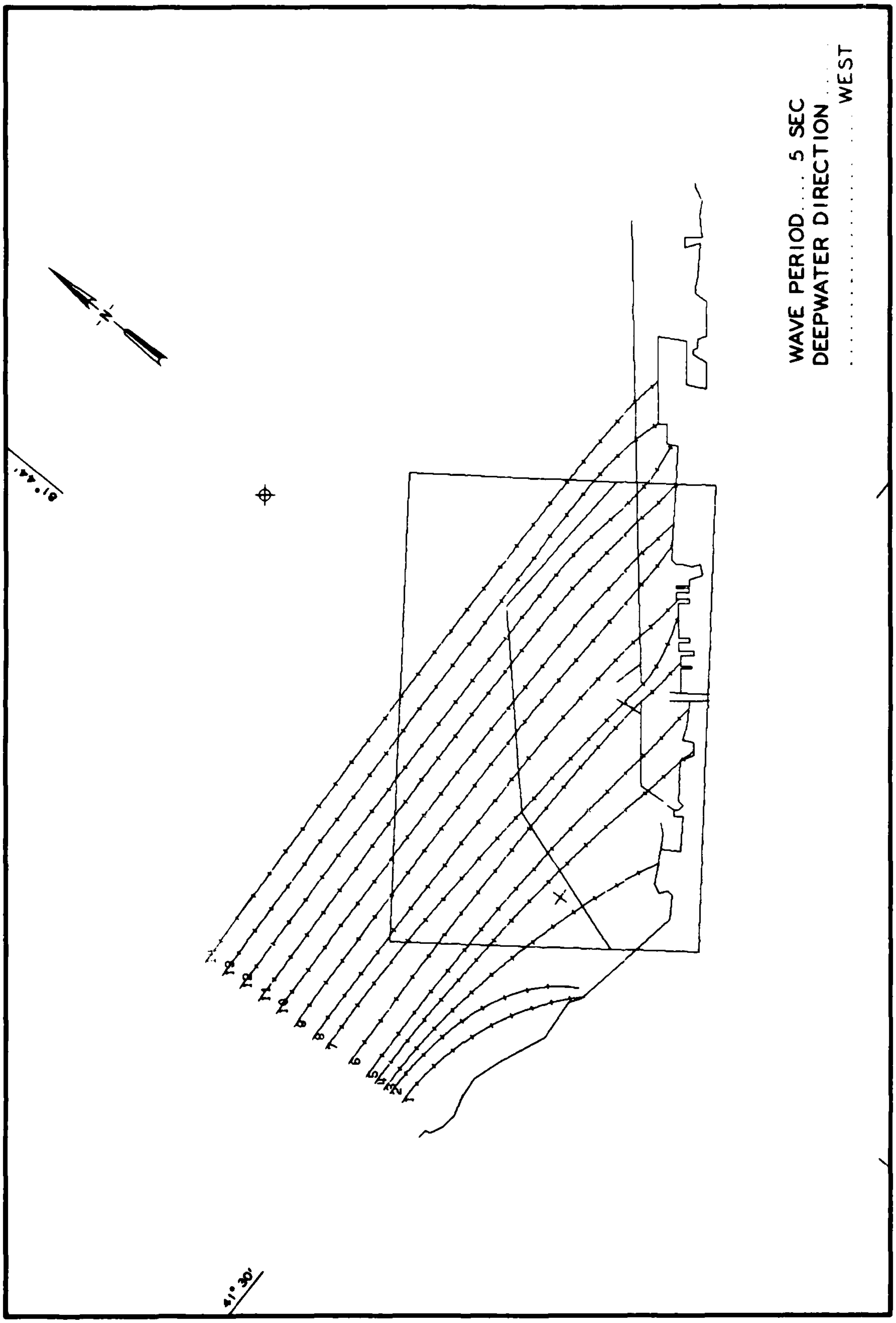



PLATE A3

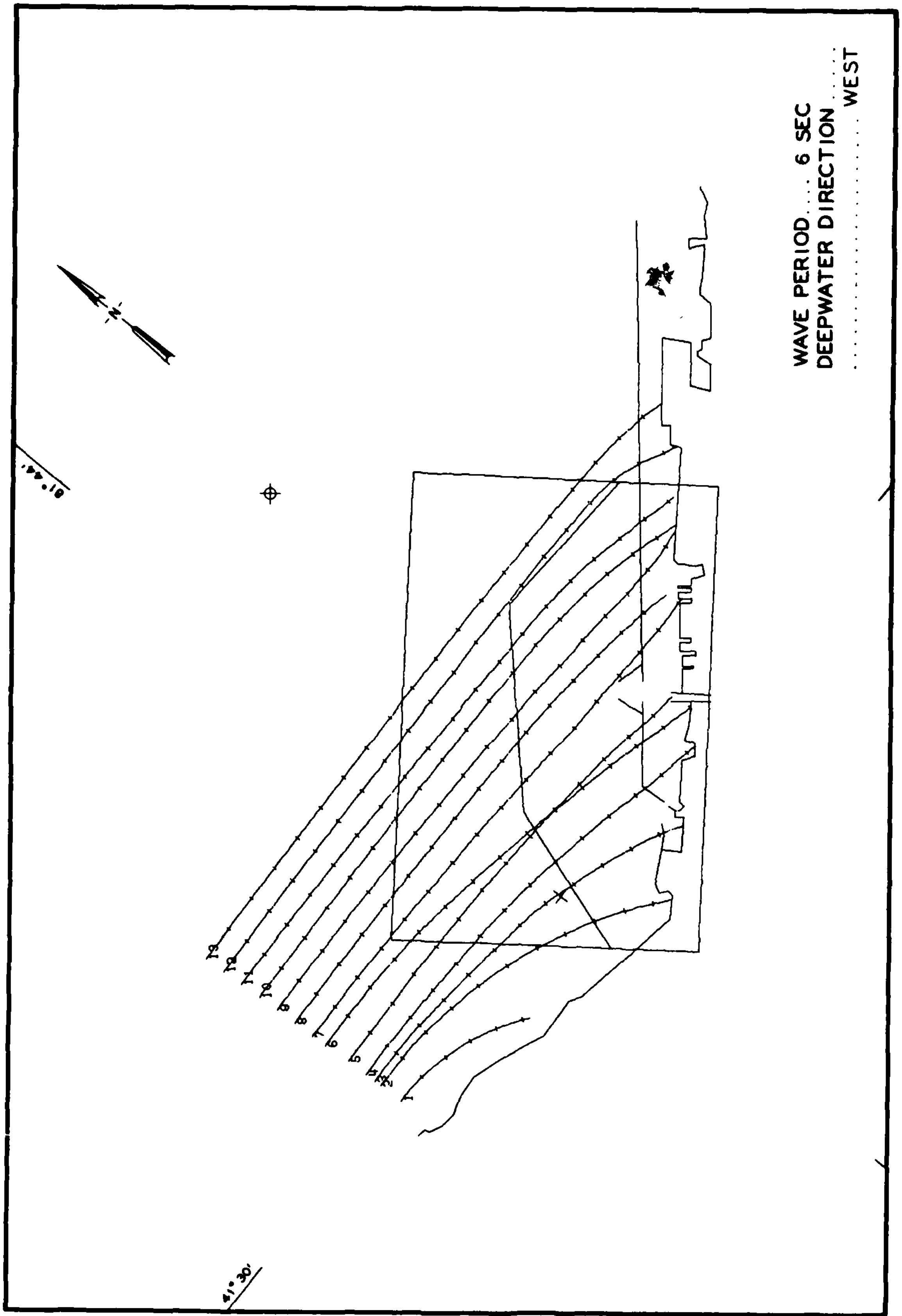



PLATE A4

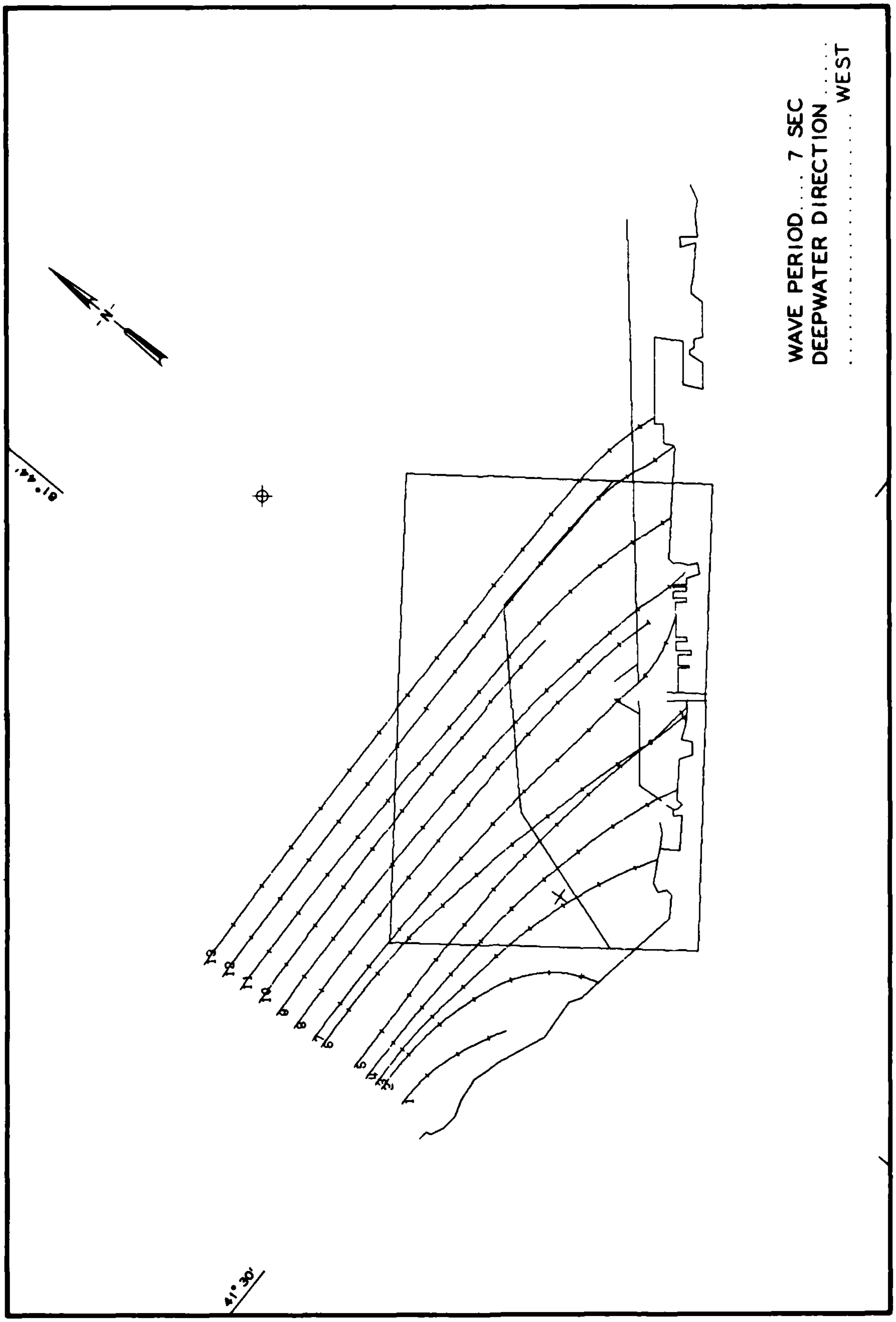



PLATE A5

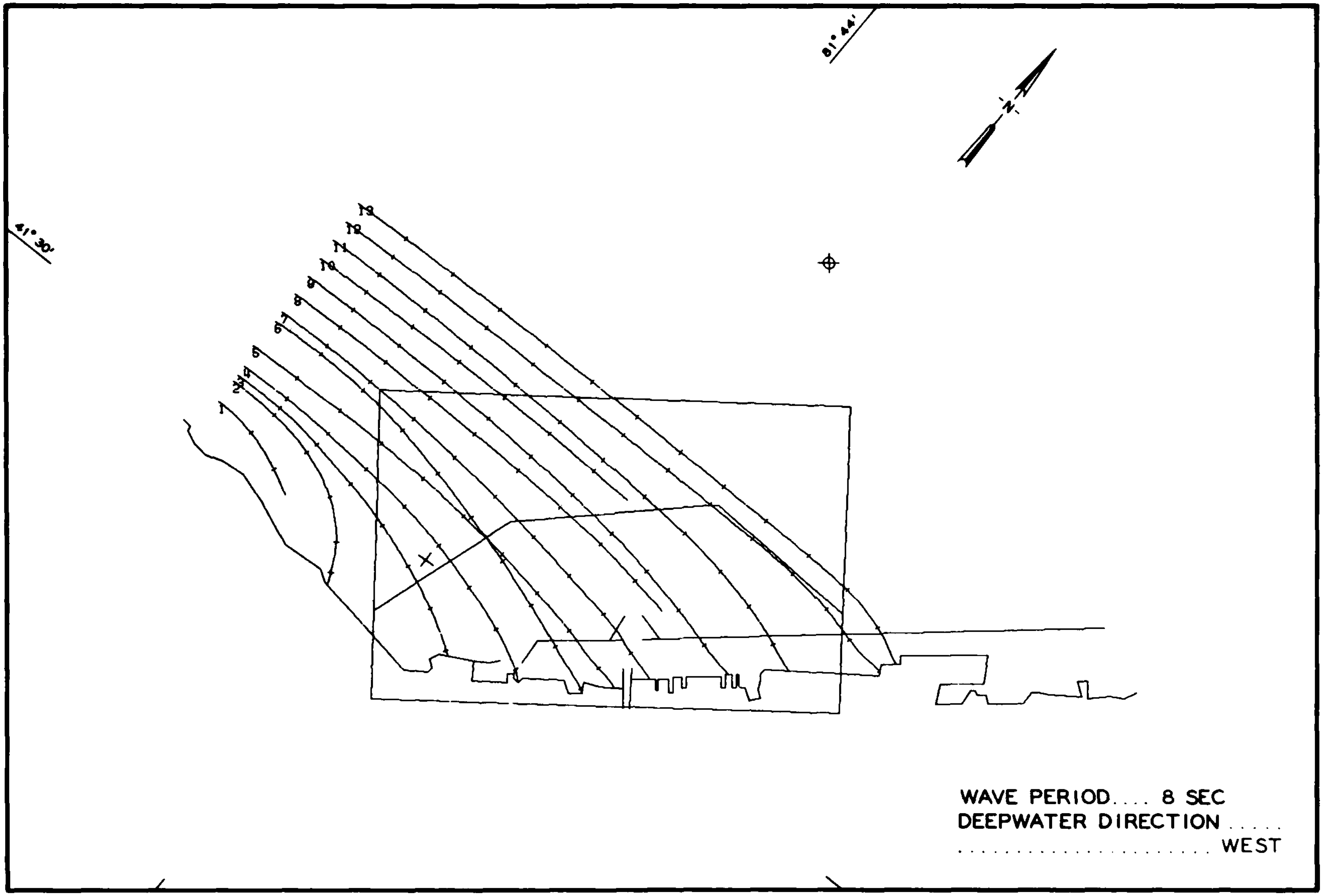



PLATE A6

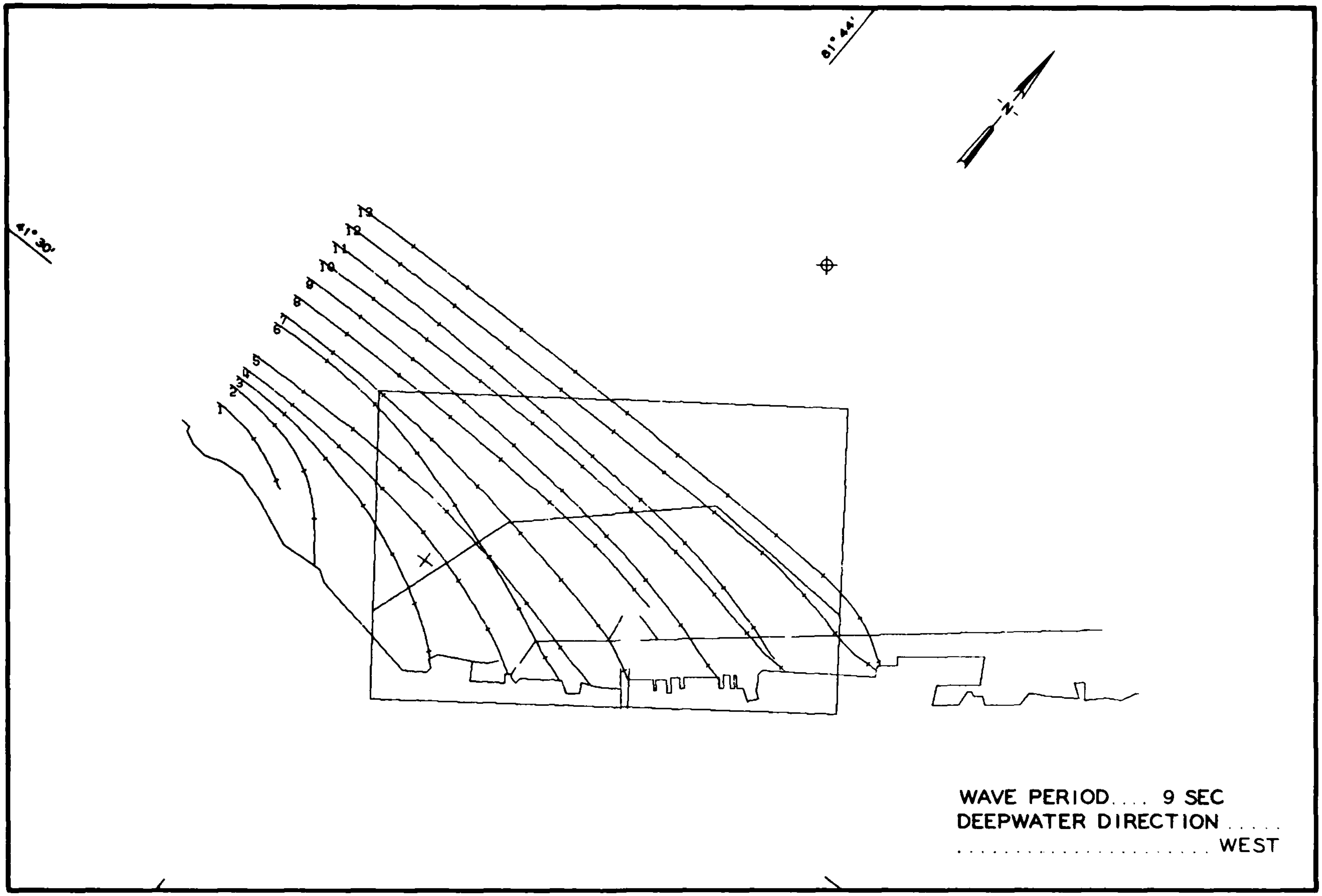

81° 44'
N
41° 30'
1
2
3
4
5
6
7
8
9
10
11
12
13
WAVE PERIOD.... 9 SEC
DEEPWATER DIRECTION.....
..................... WEST

PLATE A7

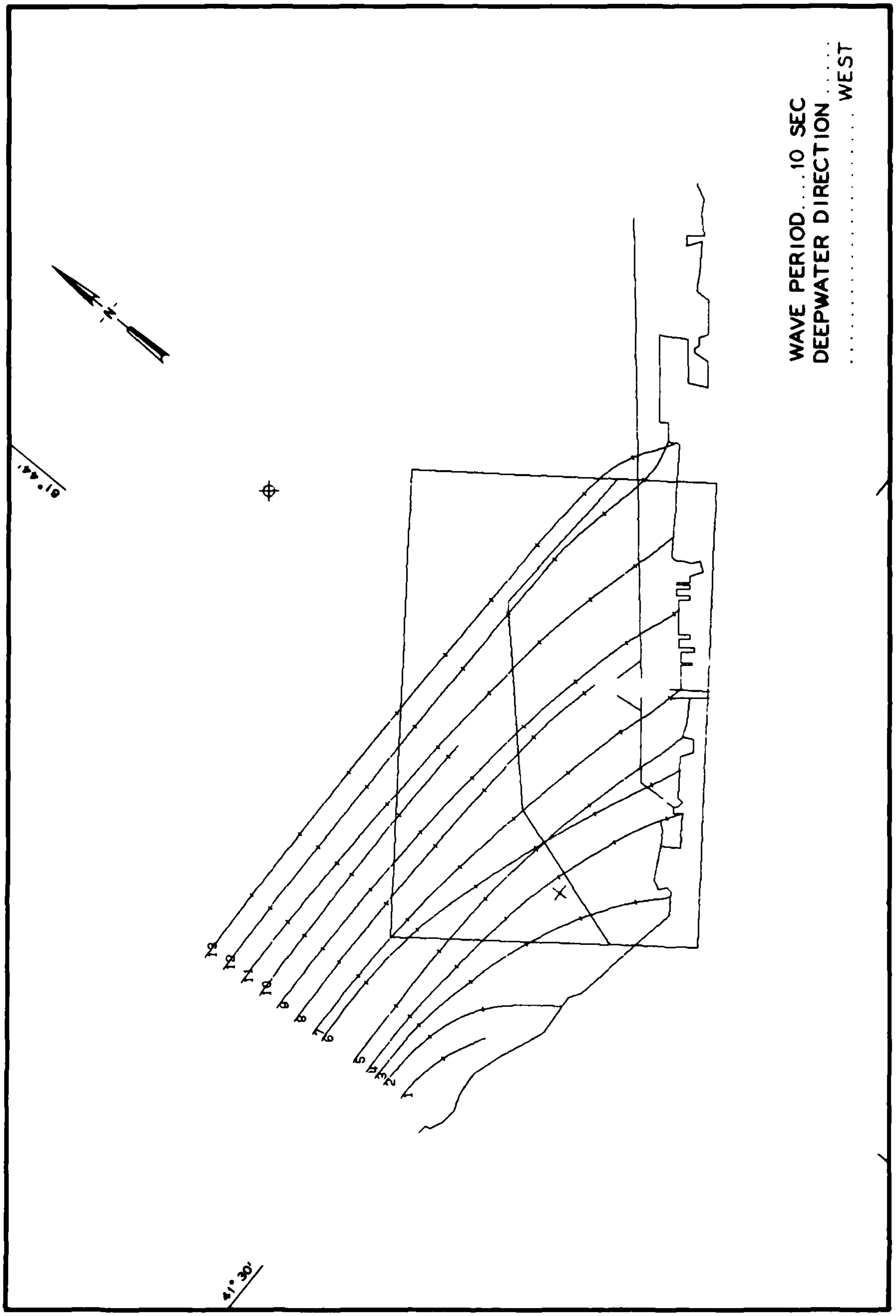



PLATE A8

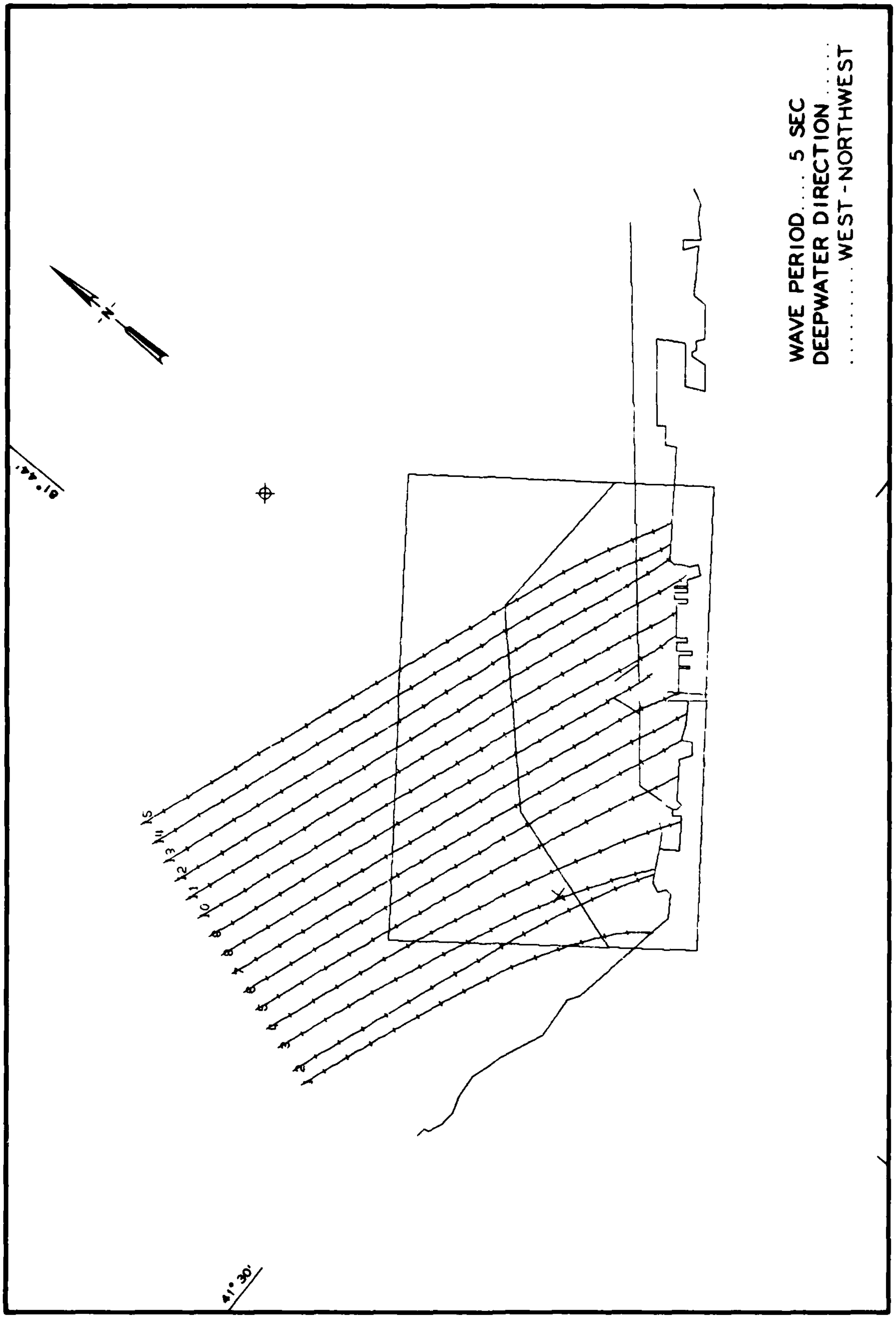

WAVE PERIOD.... 5 SEC
DEEPWATER DIRECTION
........WEST-NORTHWEST
N
81°44'
41°30'

PLATE A9

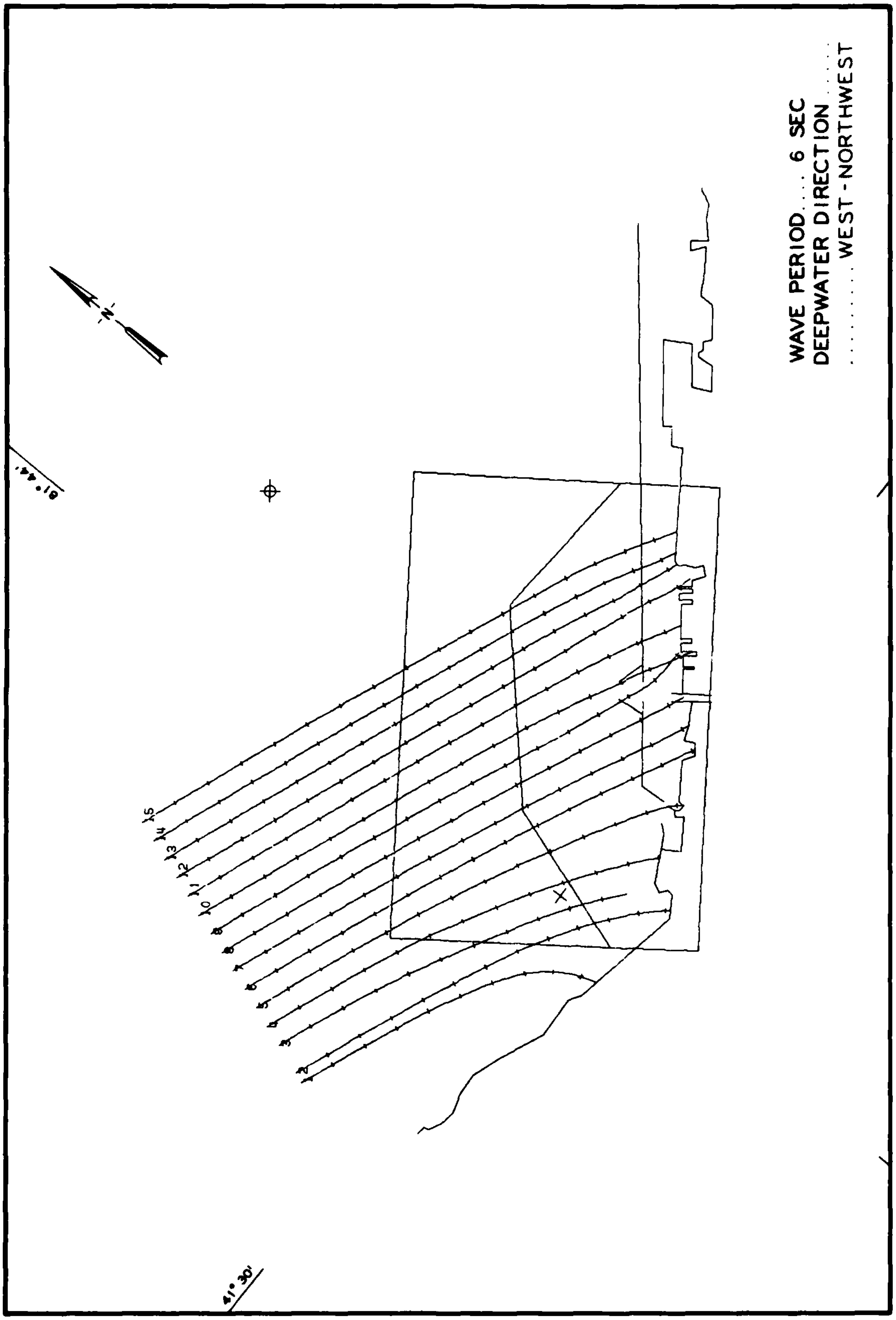

WAVE PERIOD.... 6 SEC
DEEPWATER DIRECTION
........ WEST-NORTHWEST
N
81°44'
41°30'

PLATE A10

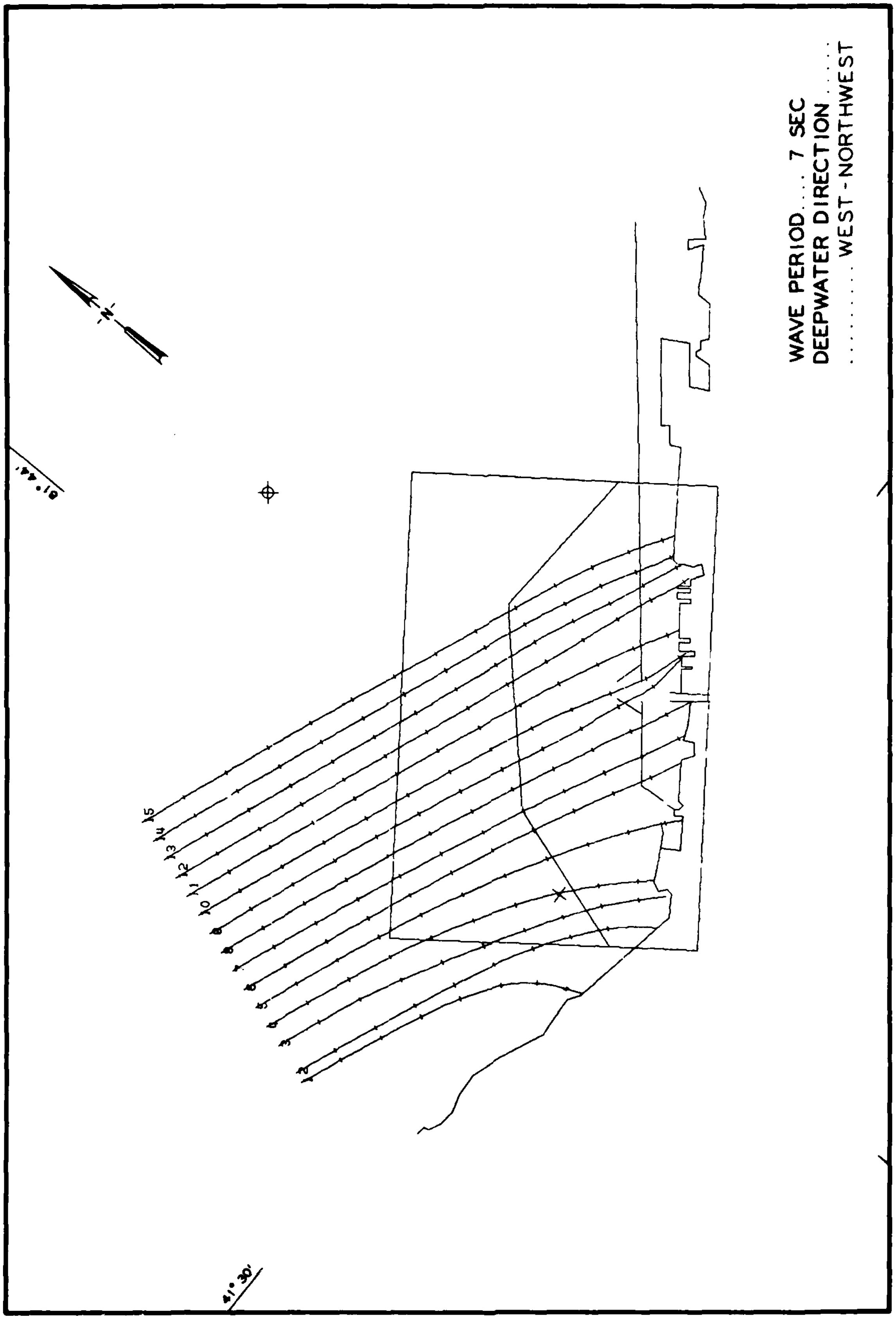

WAVE PERIOD ..... 7 SEC
DEEPWATER DIRECTION .....
......... WEST-NORTHWEST
N
81°44'
41°30'

PLATE A11

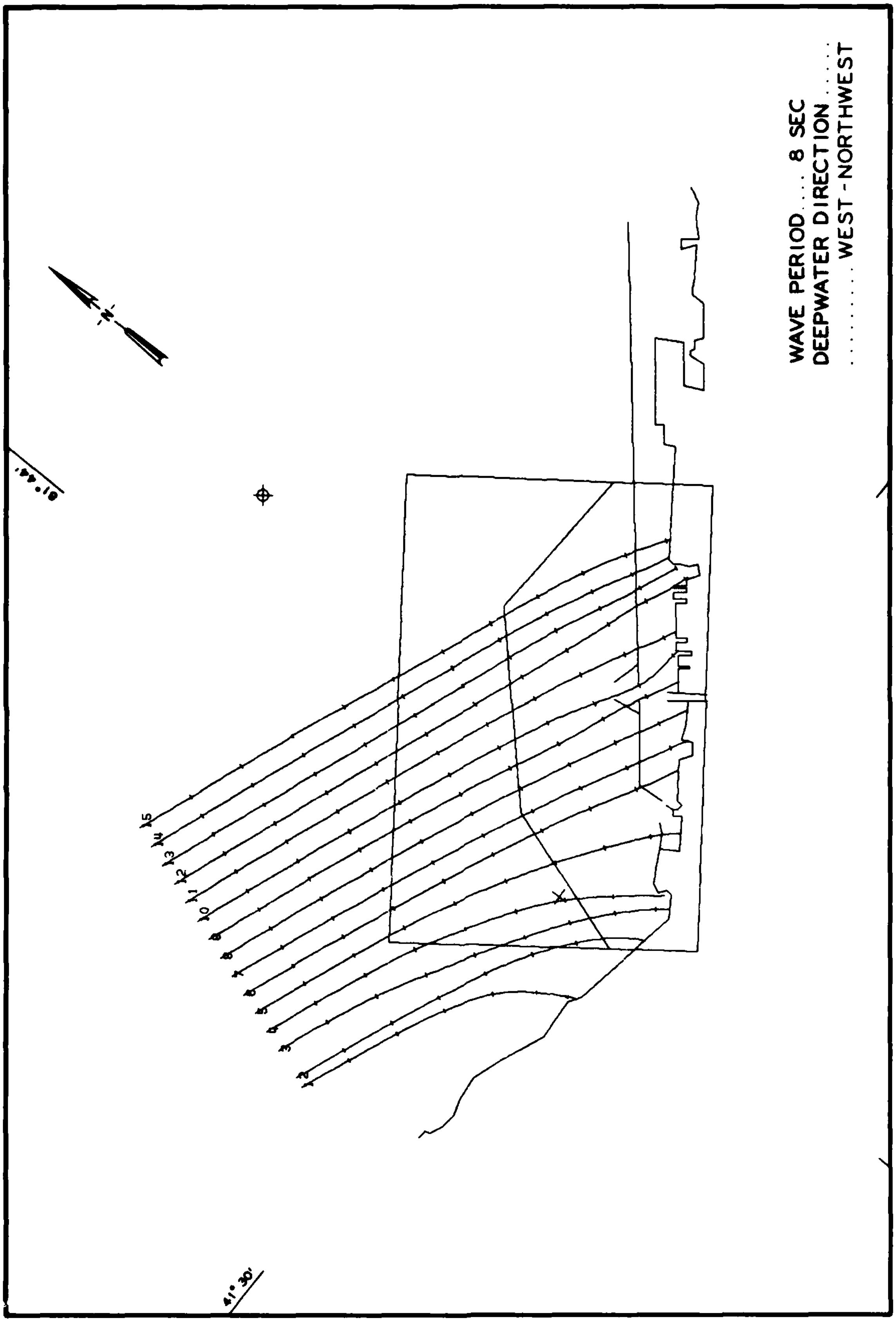
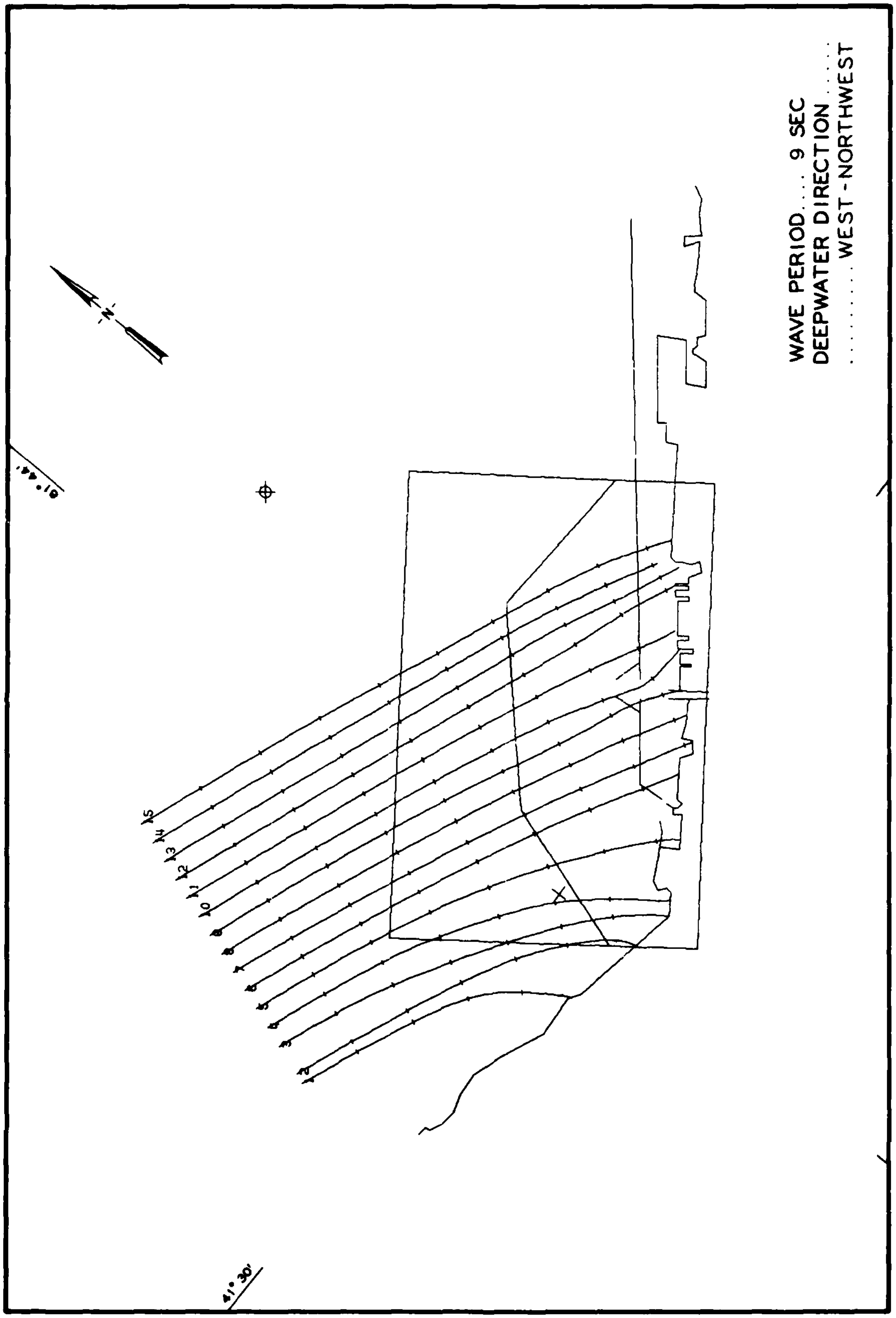

WAVE PERIOD . . . . 8 SEC
DEEPWATER DIRECTION
. . . . . . . . WEST-NORTHWEST
N
81°44'
41°30'

PLATE A12



WAVE PERIOD . . . . 9 SEC
DEEPWATER DIRECTION . . . .
. . . . . . . . WEST-NORTHWEST
N
41° 30'


PLATE A13

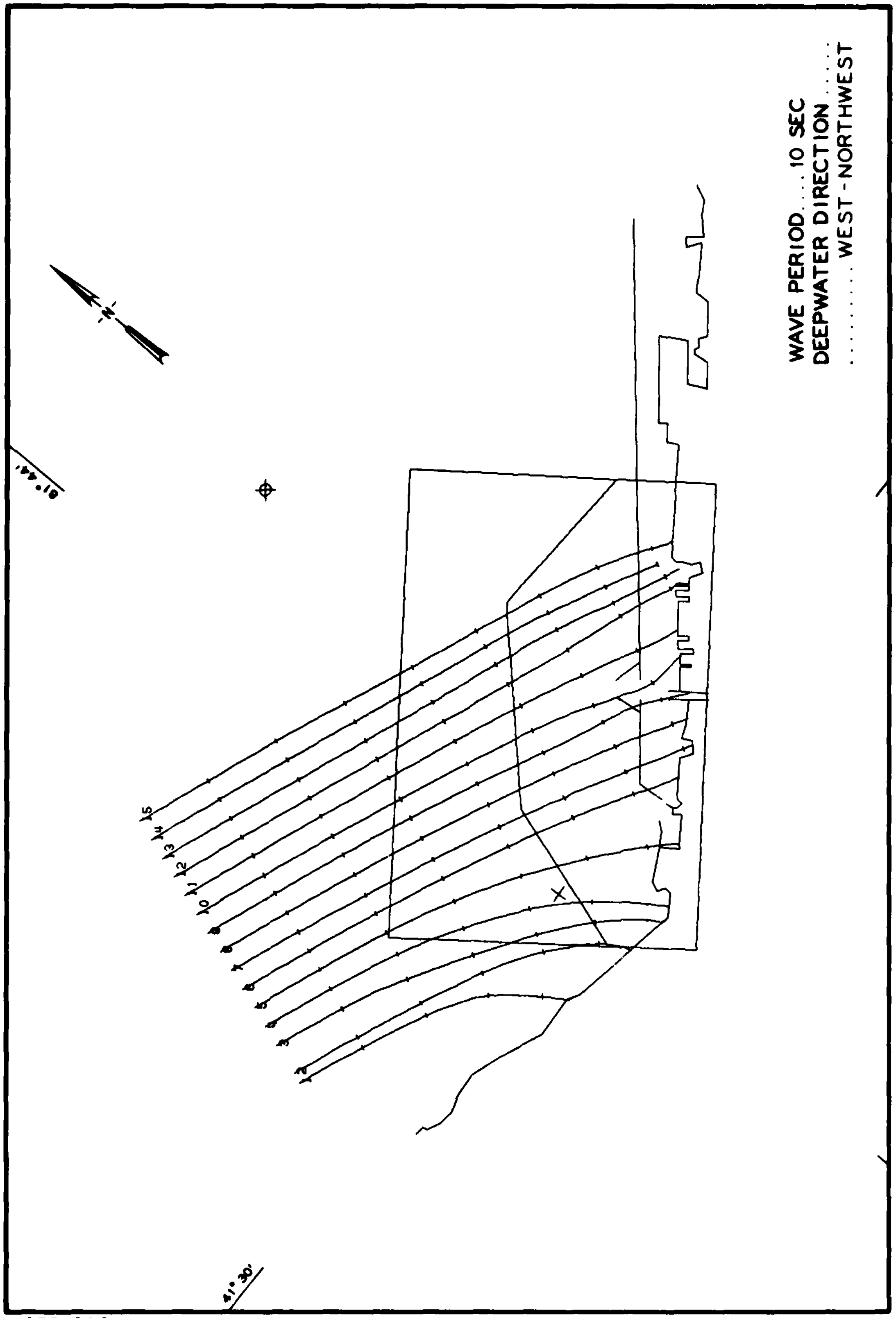

WAVE PERIOD .... 10 SEC
DEEPWATER DIRECTION ........
........ WEST-NORTHWEST
N
81°44'
41°30'

PLATE A14

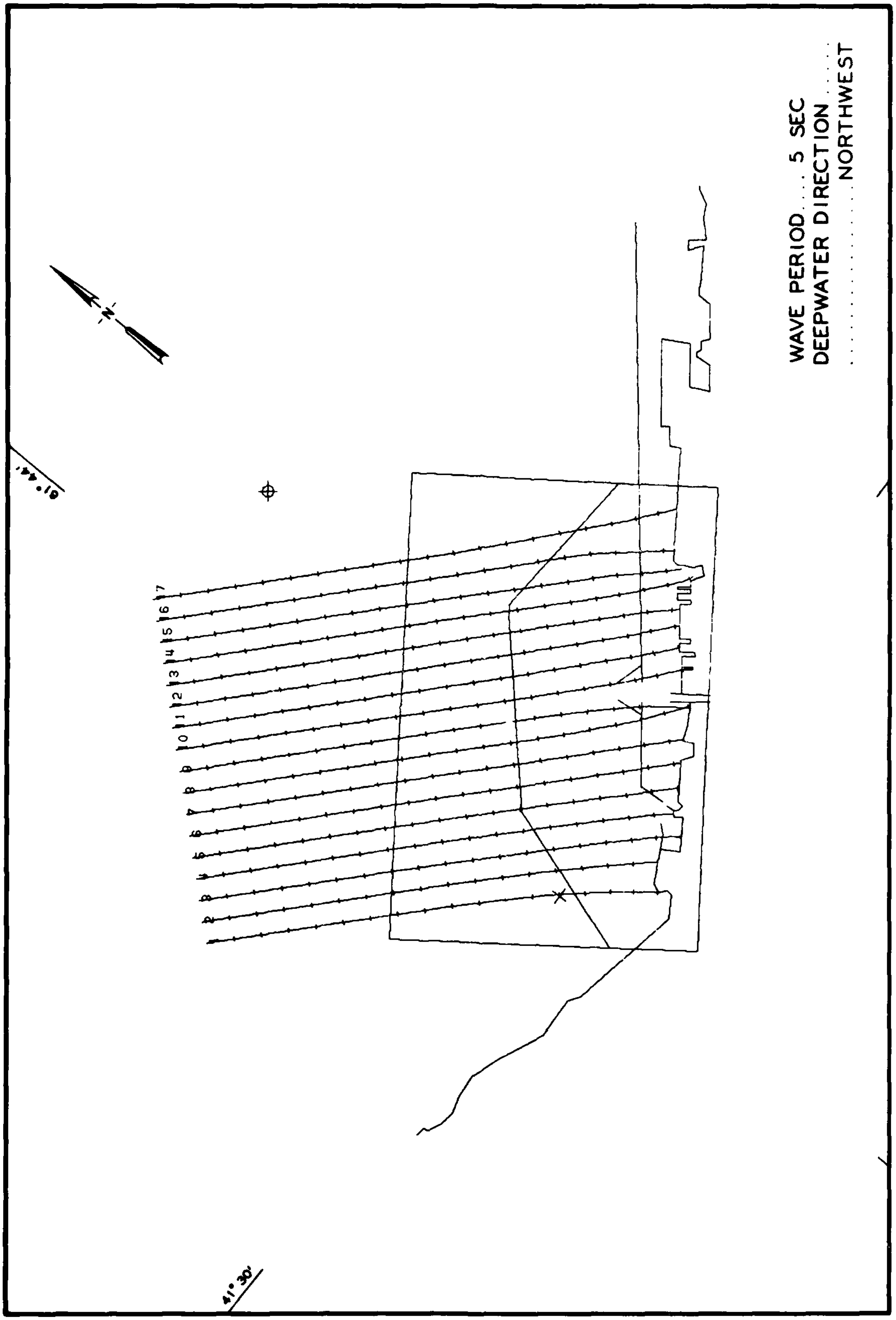



PLATE A15

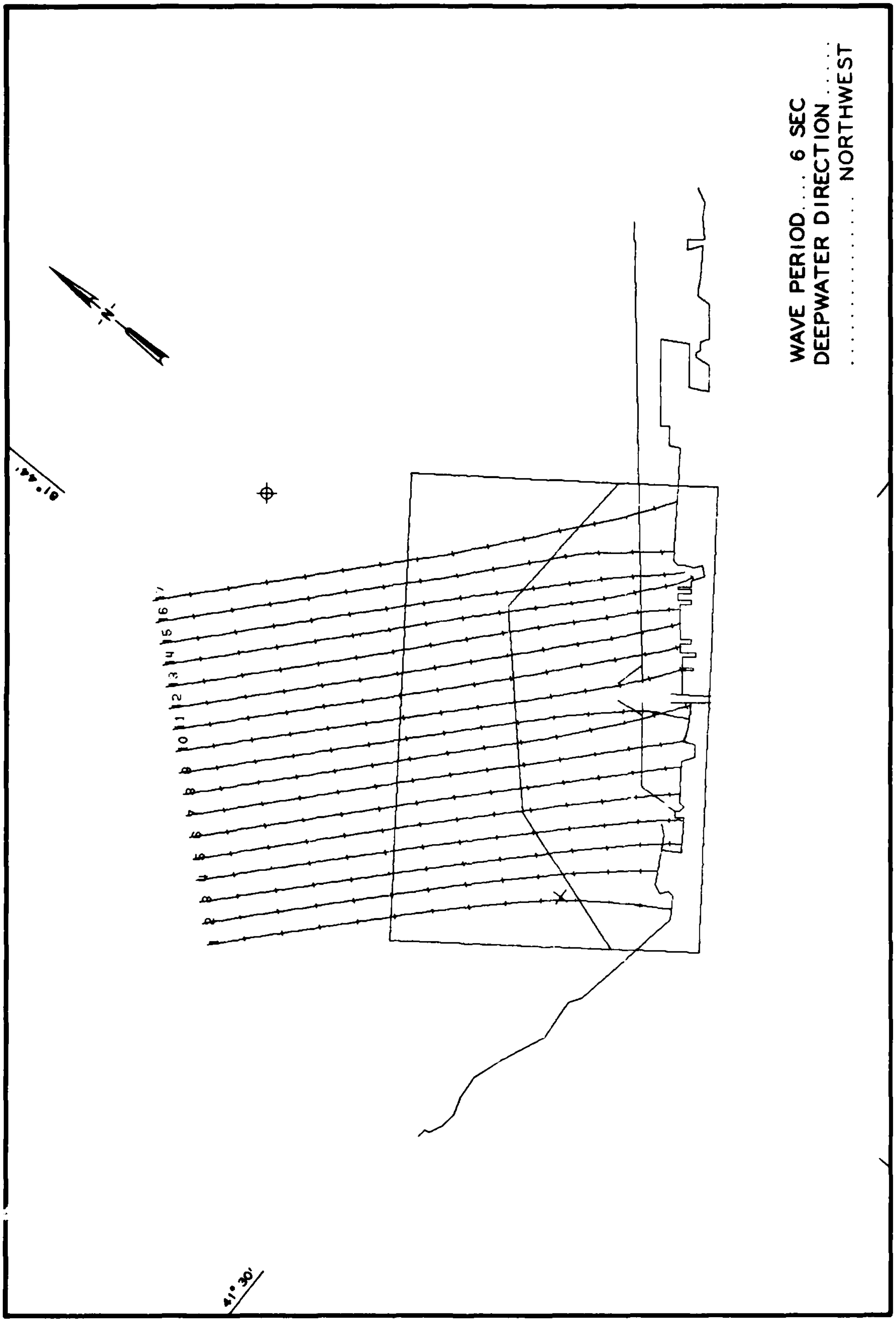

WAVE PERIOD . . . 6 SEC
DEEPWATER DIRECTION
NORTHWEST
N
81°44'
41°30'

PLATE A16

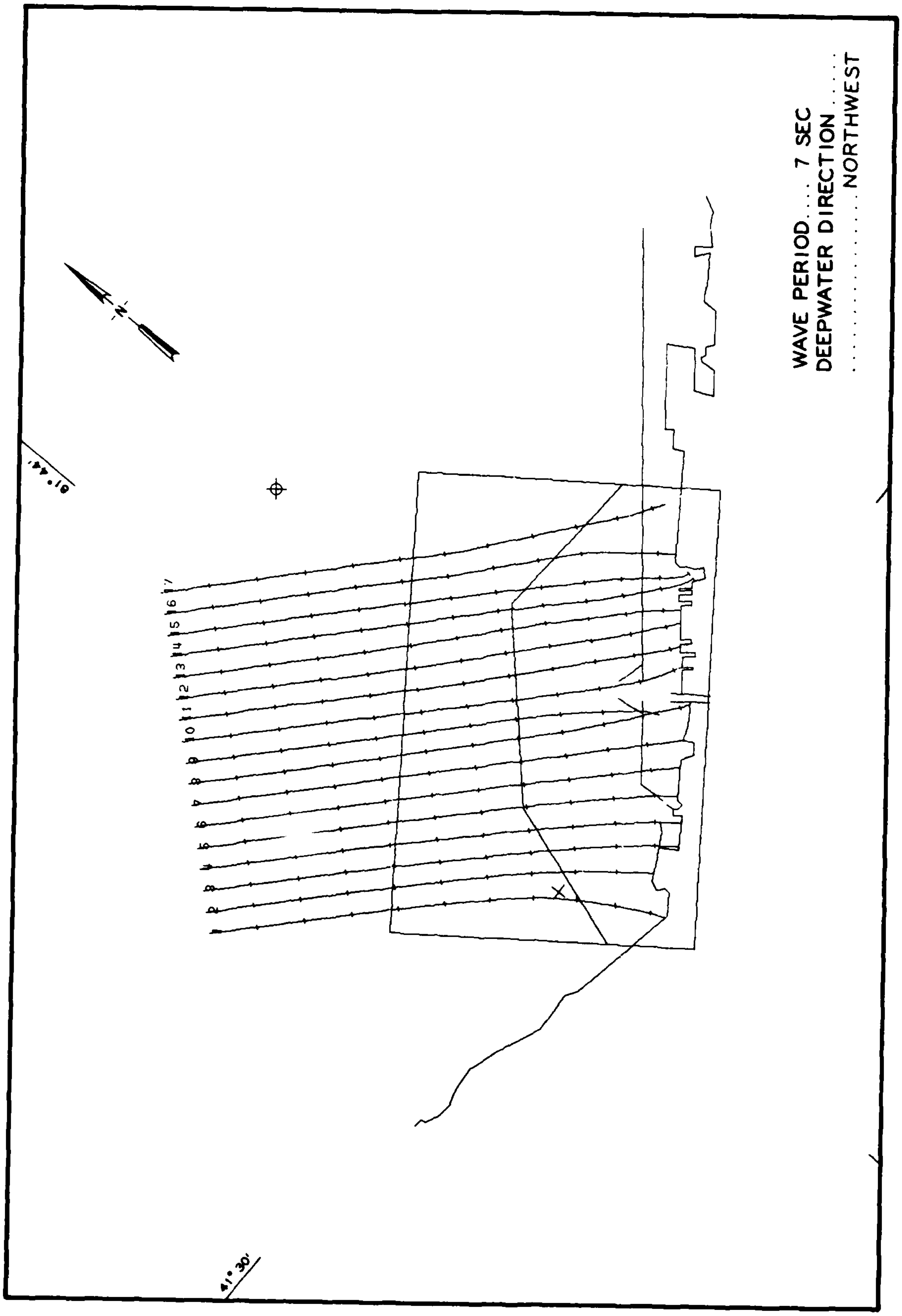



PLATE A17

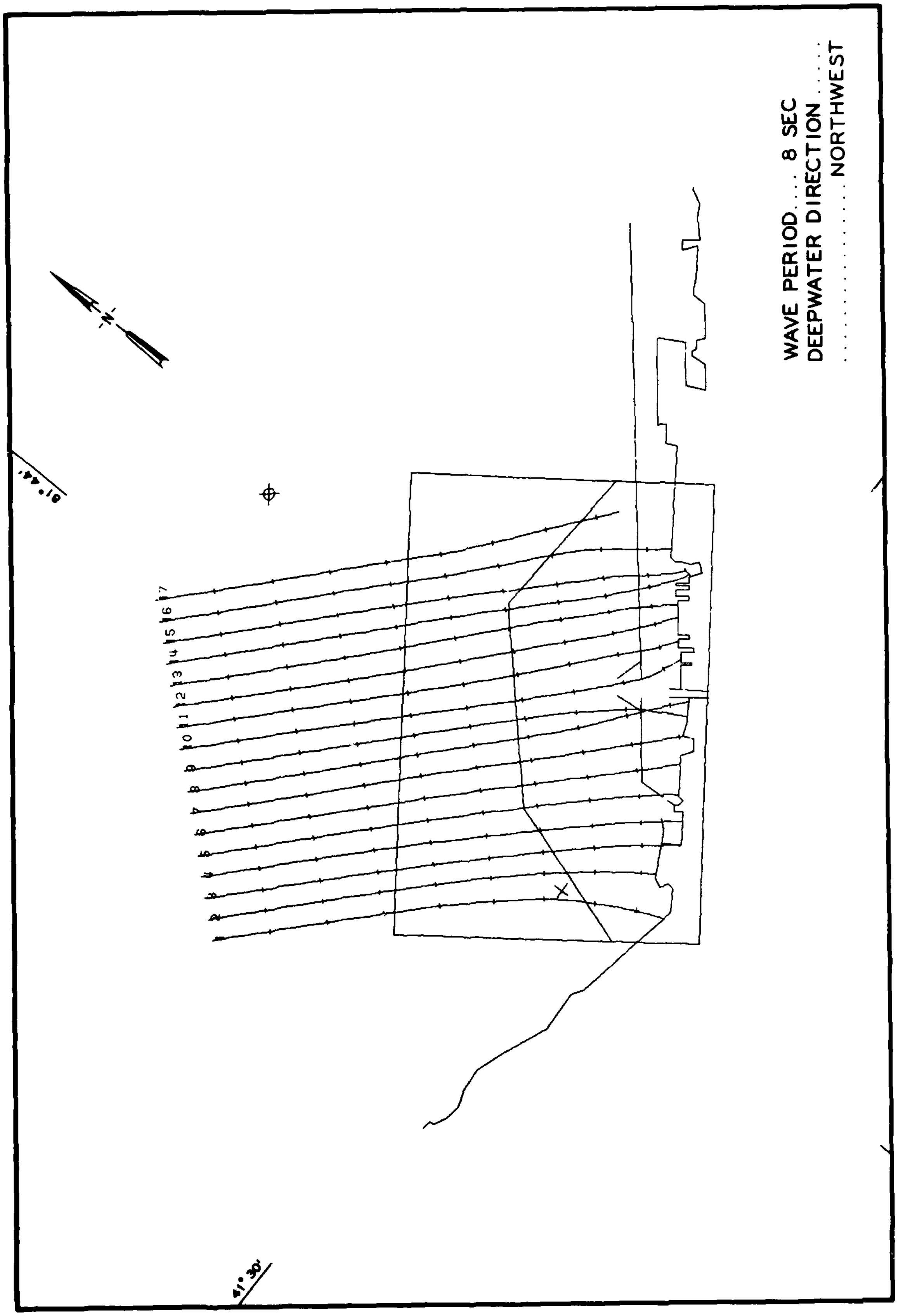
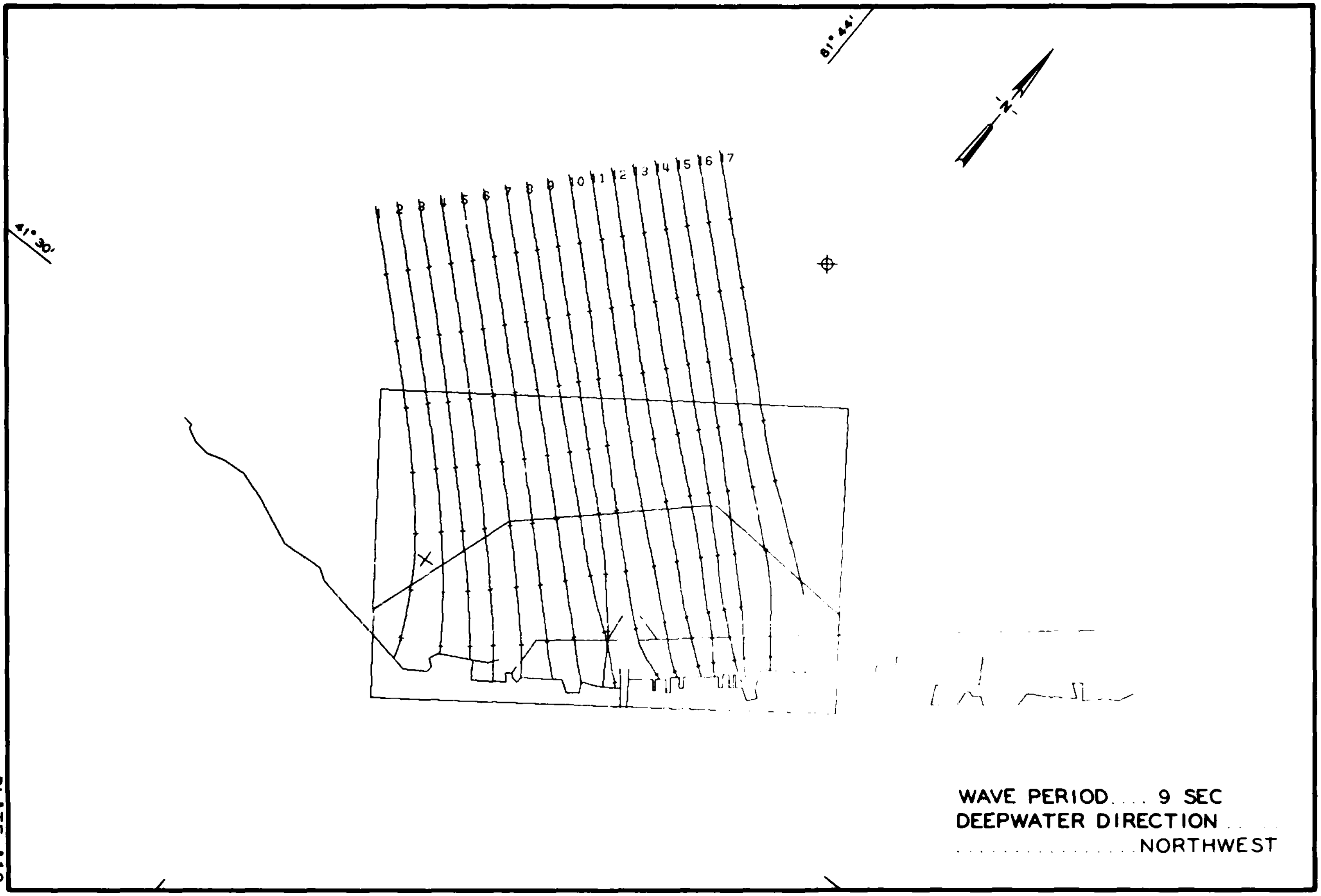

WAVE PERIOD . . . 8 SEC
DEEPWATER DIRECTION
. . . . . . . . . . . NORTHWEST
N
81°44'
41°30'

PLATE A18



81°44'
N
41°30'
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
WAVE PERIOD .... 9 SEC
DEEPWATER DIRECTION ..
.................. NORTHWEST


PLATE A19

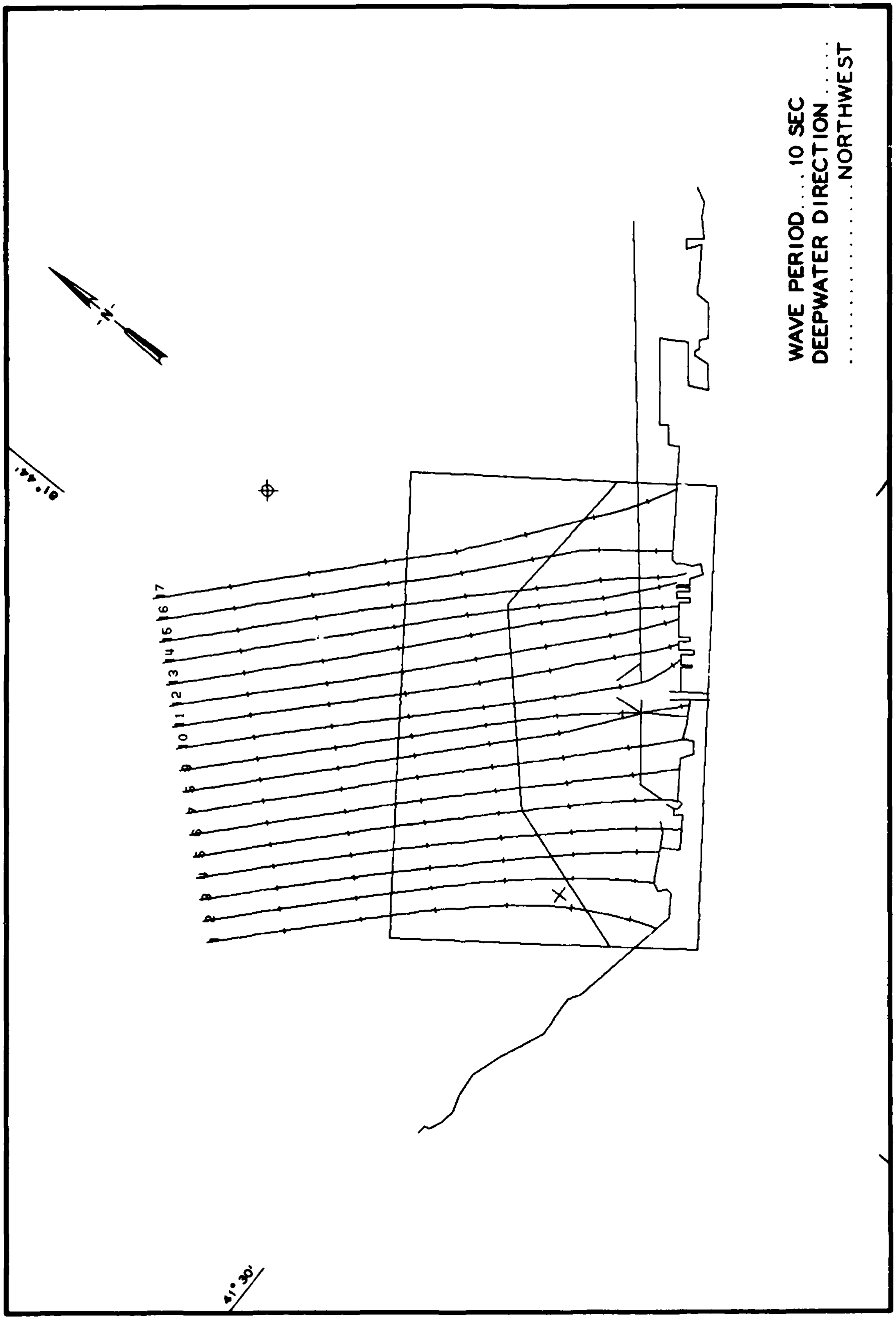
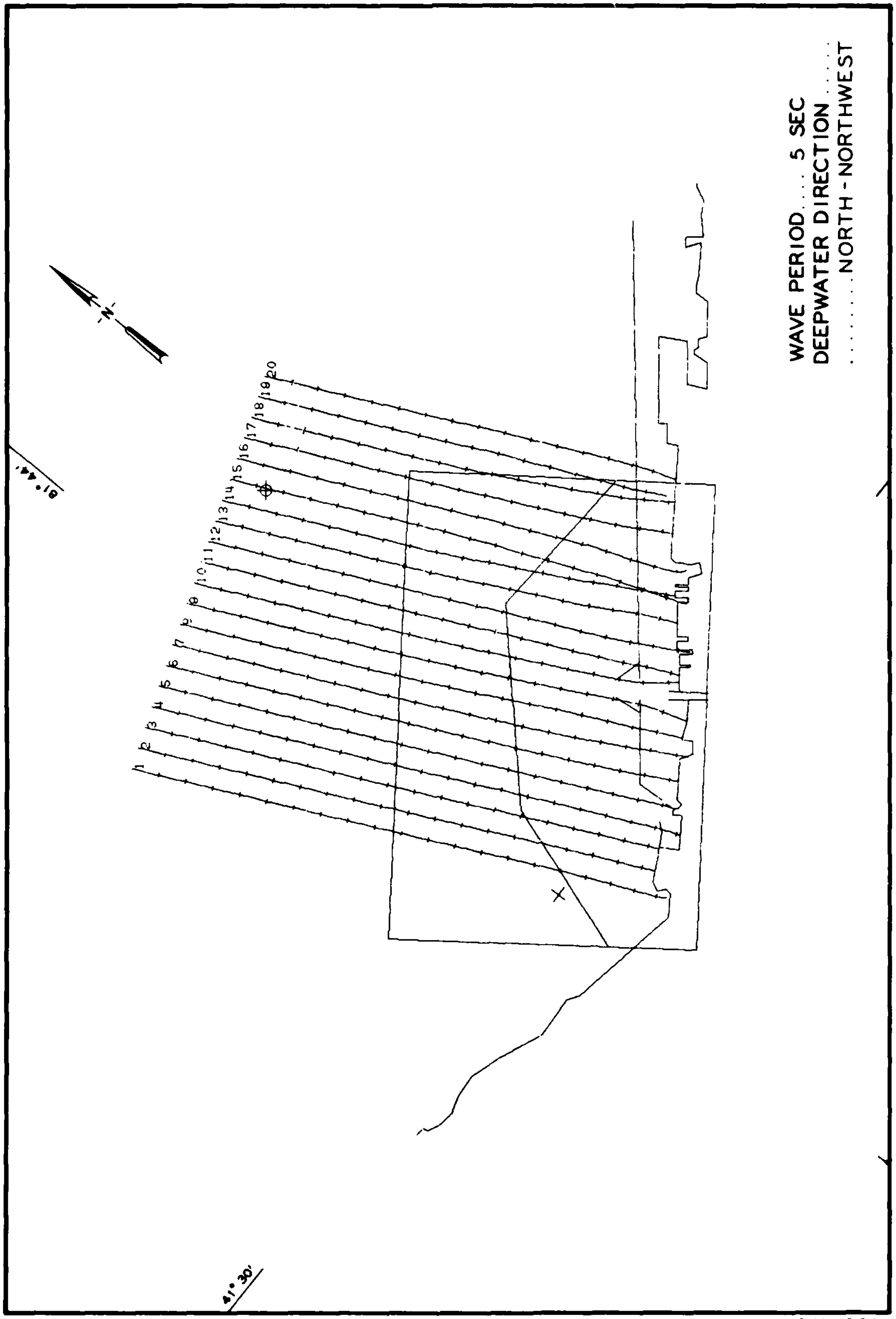

WAVE PERIOD . . . . 10 SEC
DEEPWATER DIRECTION . . . . .
. . . . . . . . . . . . NORTHWEST
N
41° 30'
81° 44'

PLATE A20


WAVE PERIOD ..... 5 SEC
DEEPWATER DIRECTION
........ NORTH-NORTHWEST
N
81°44'
41°30'
1
2
3
4
5
6
7
8
9
10
11
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16
17
18
19
20

PLATE A21

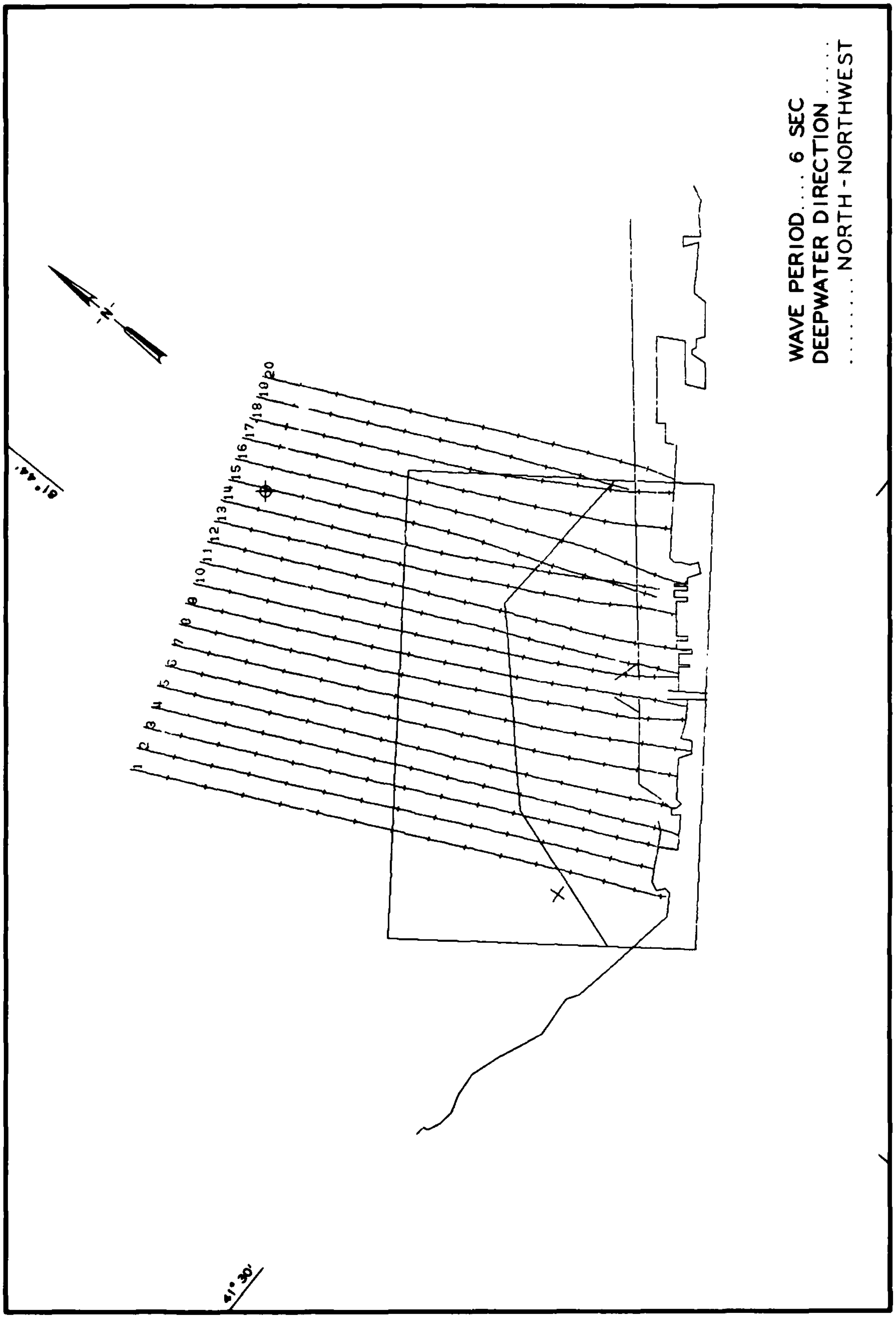
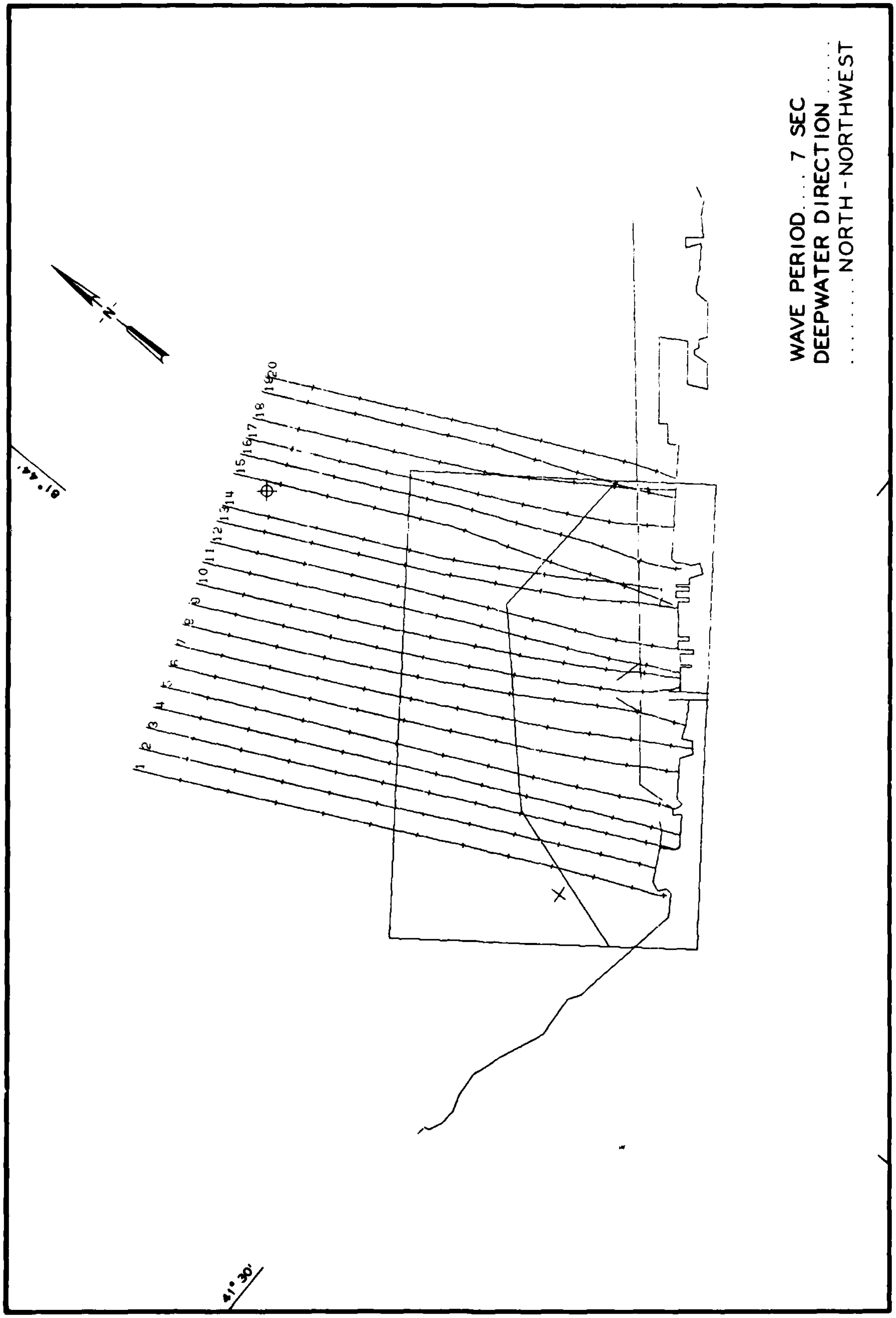

WAVE PERIOD.....6 SEC
DEEPWATER DIRECTION........
.........NORTH-NORTHWEST
N
81°44'
41°30'

PLATE A22


WAVE PERIOD . . . 7 SEC
DEEPWATER DIRECTION
. . . . . . . . NORTH - NORTHWEST
N
41° 30'
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20

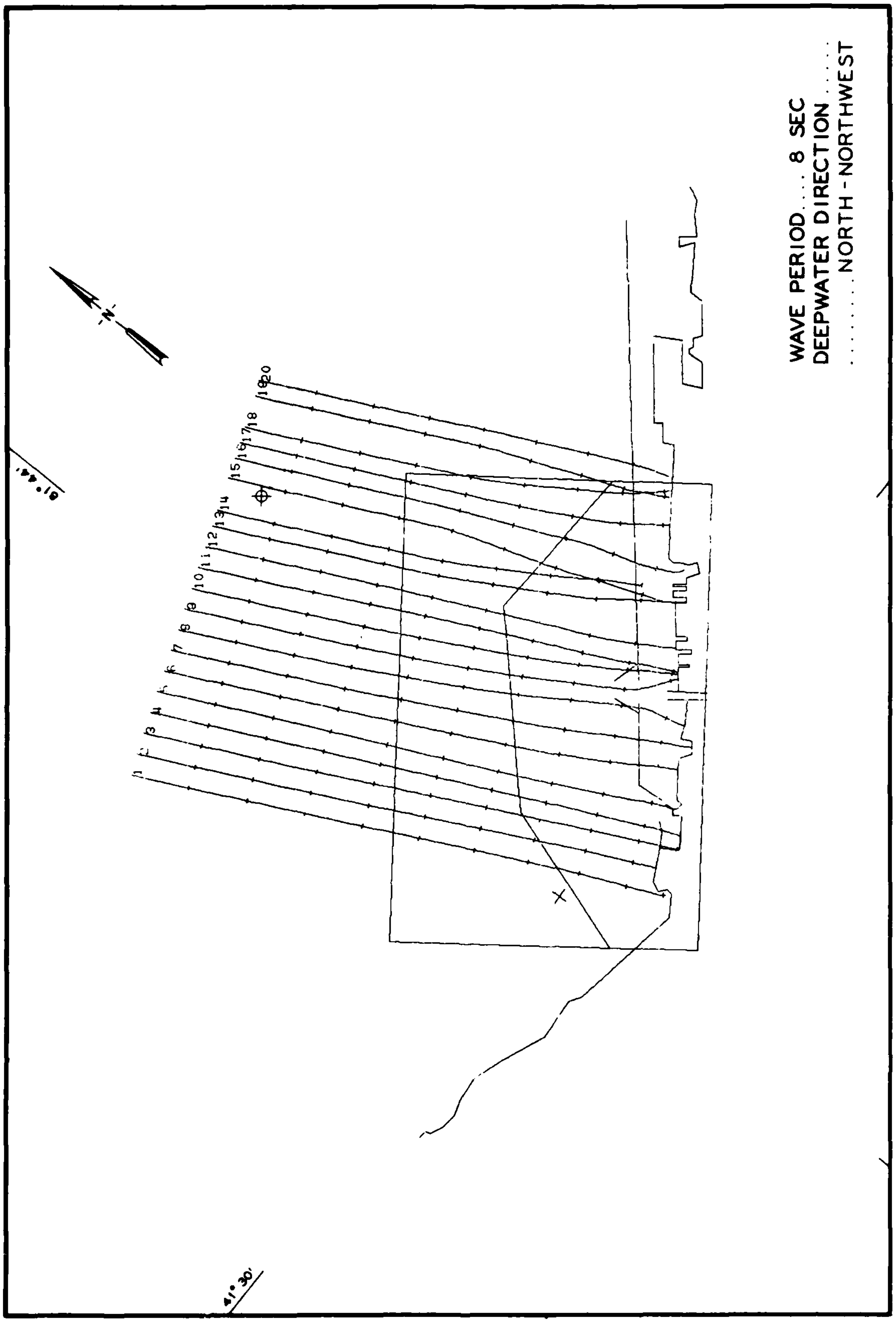

WAVE PERIOD.... 8 SEC
DEEPWATER DIRECTION
........NORTH-NORTHWEST
N
41° 30'

PLATE A24

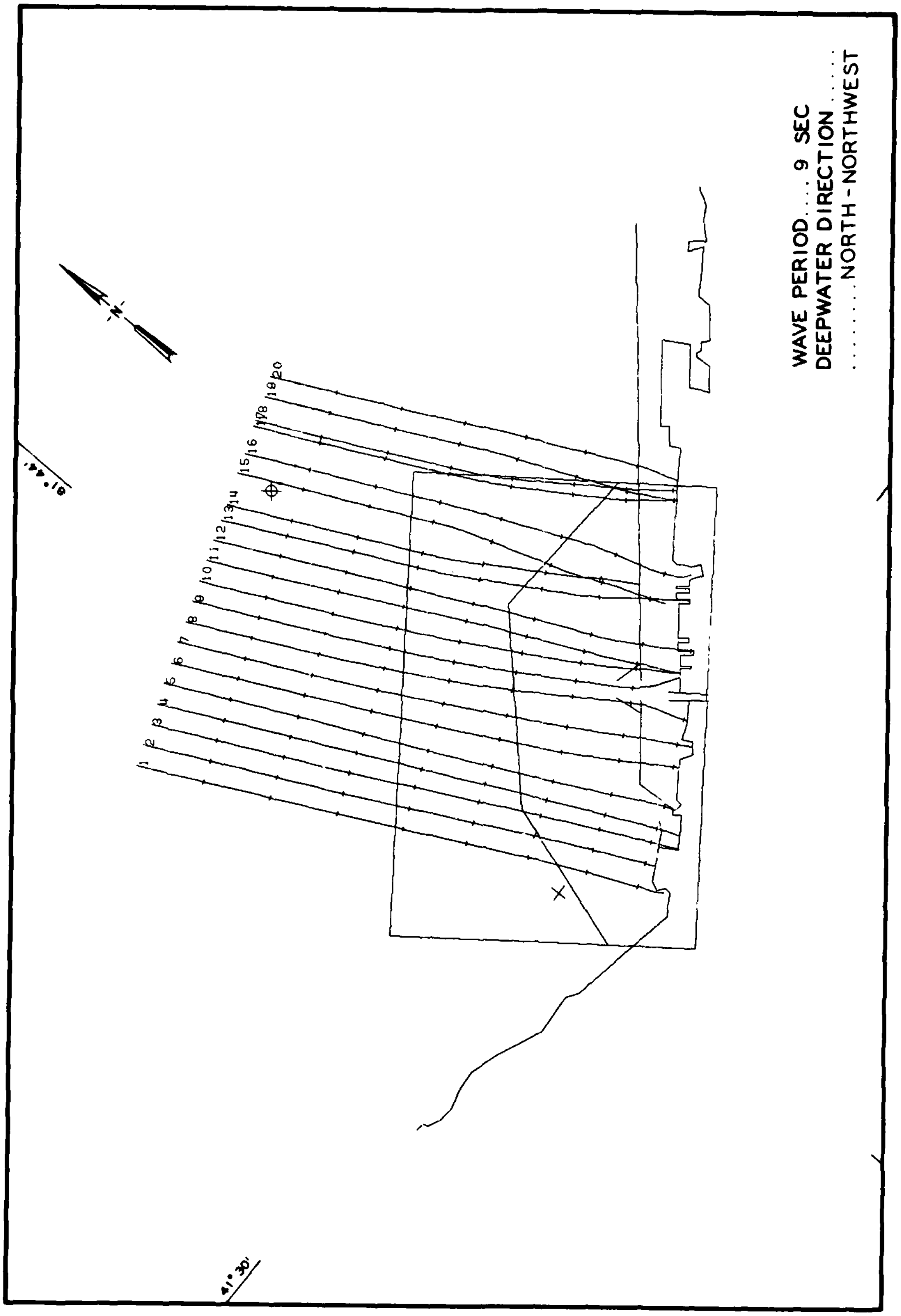

WAVE PERIOD.....9 SEC
DEEPWATER DIRECTION
.......NORTH-NORTHWEST
N
41°30'

PLATE A25

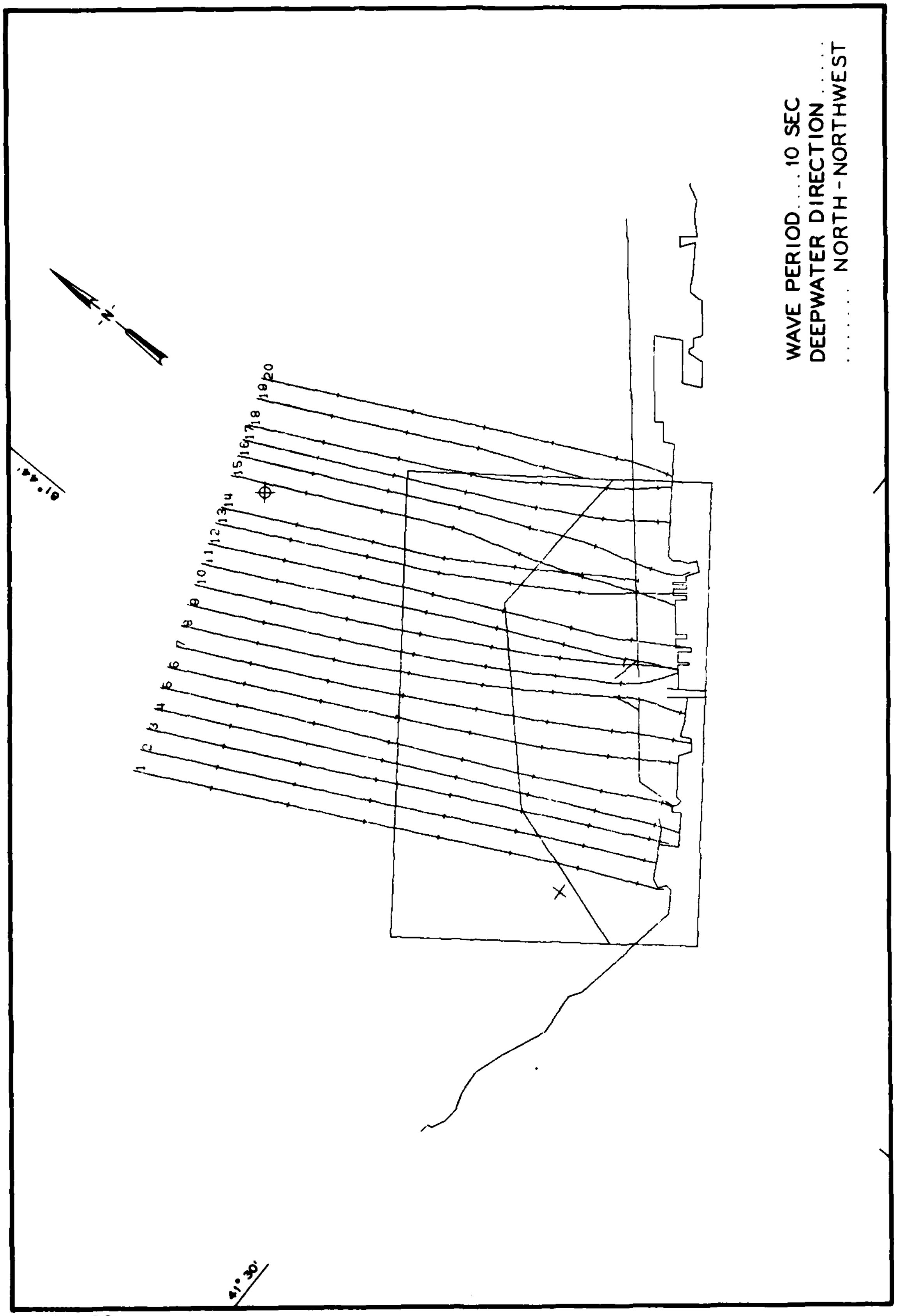

WAVE PERIOD....10 SEC
DEEPWATER DIRECTION
NORTH-NORTHWEST
41° 30'

PLATE A26

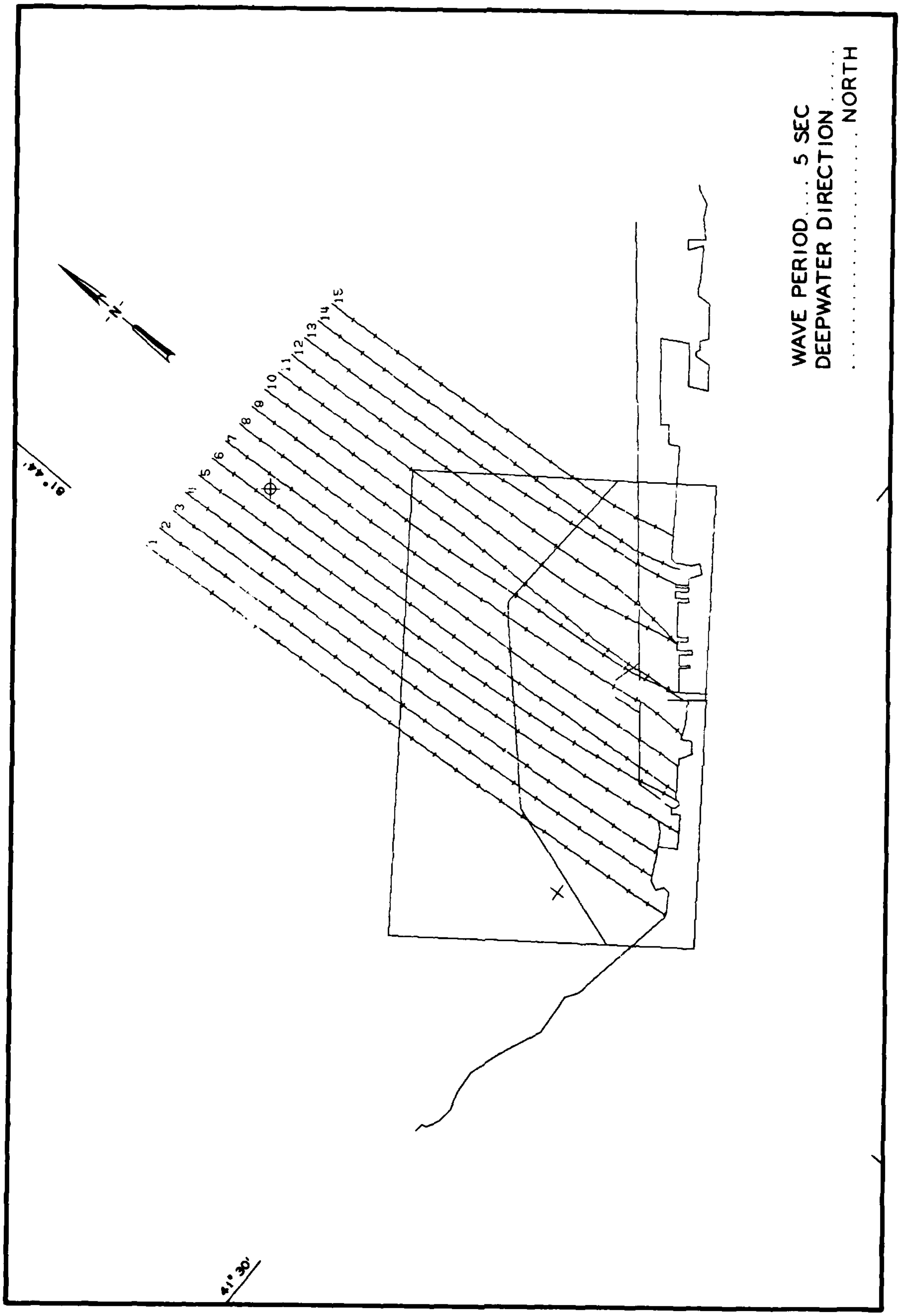

WAVE PERIOD ..... 5 SEC
DEEPWATER DIRECTION ..... NORTH
N
41° 30'
81° 44'
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15

PLATE A27

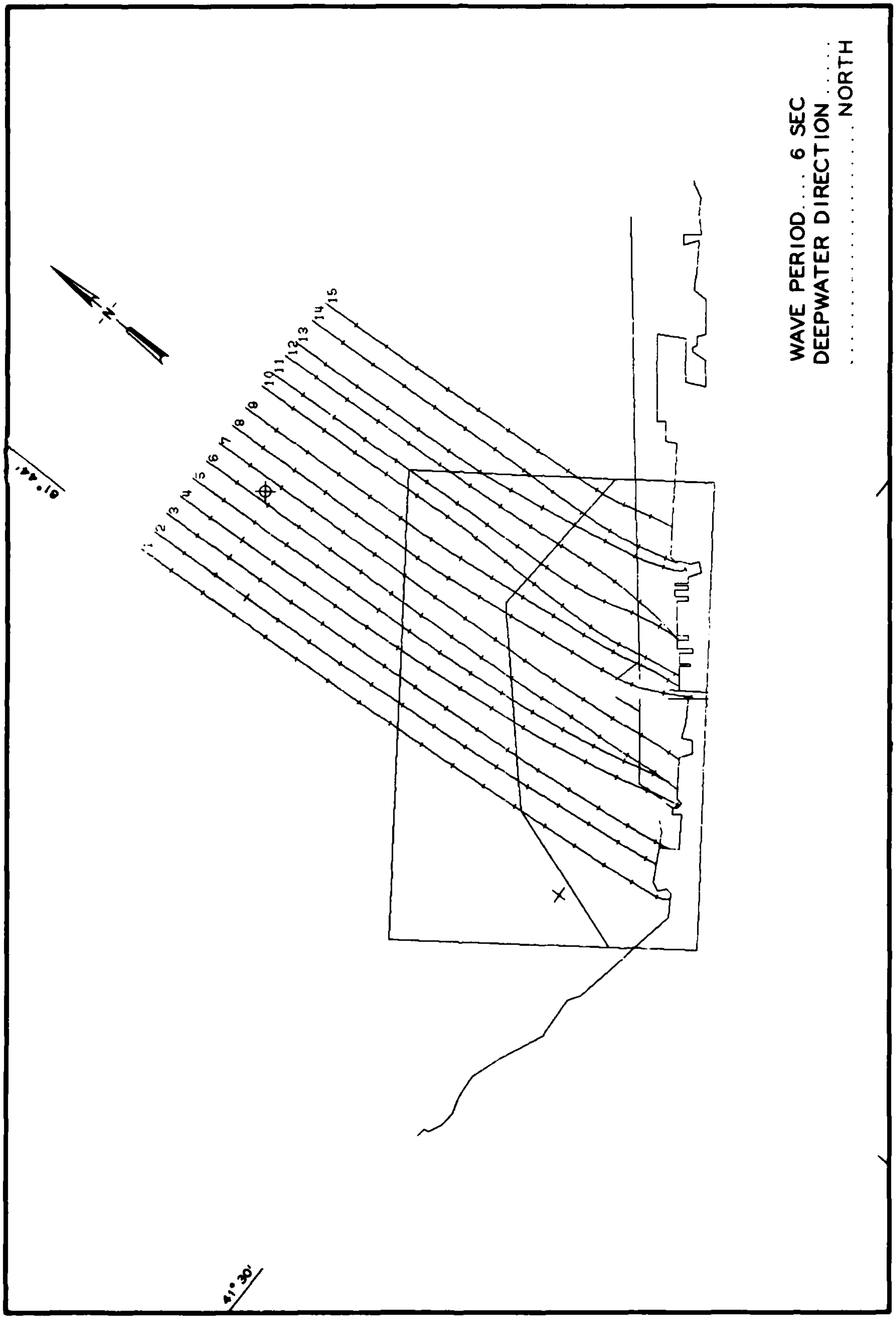

WAVE PERIOD .... 6 SEC
DEEPWATER DIRECTION ........ NORTH
N
81°44'
41°30'
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15

PLATE A28

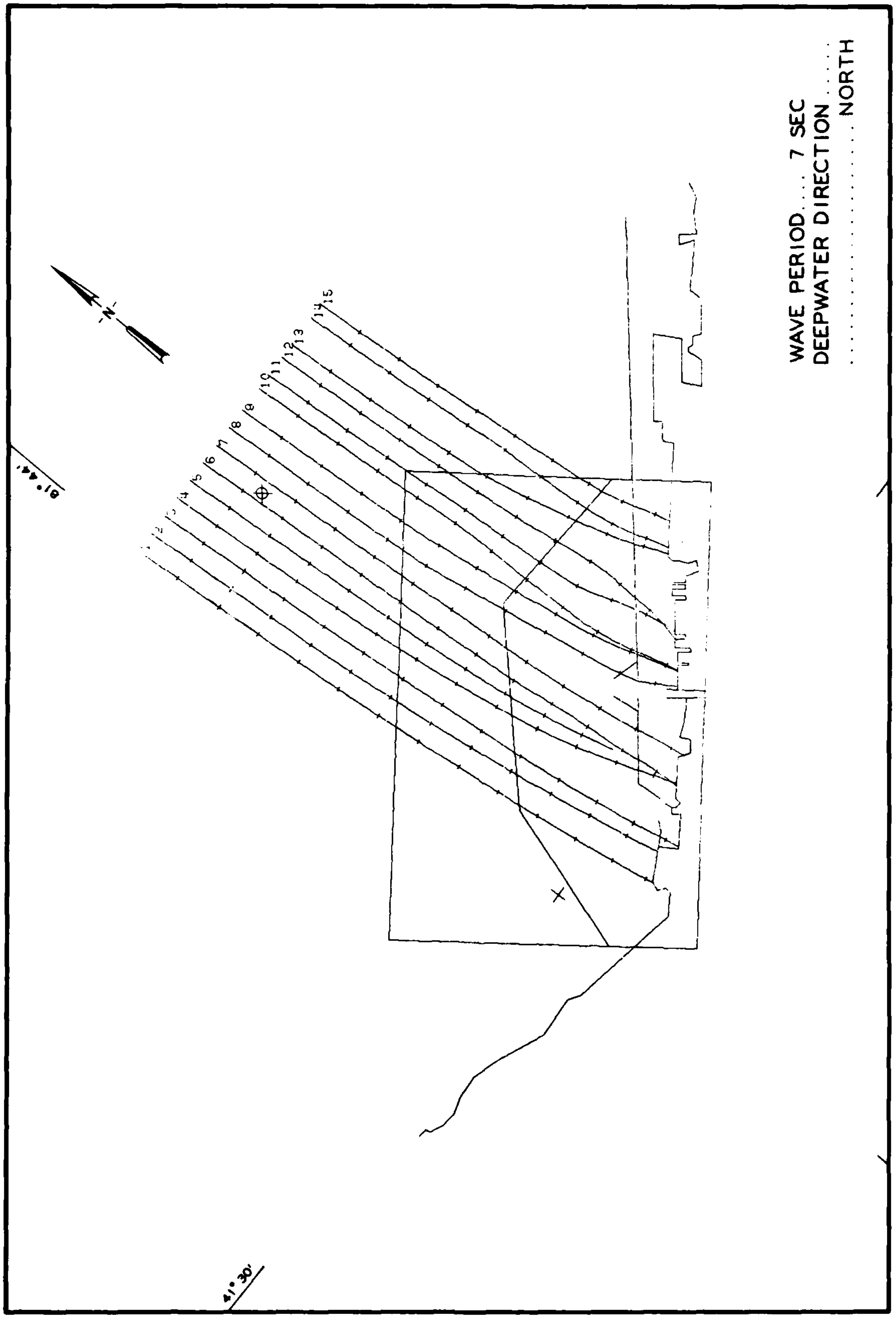

WAVE PERIOD.... 7 SEC
DEEPWATER DIRECTION......
.........NORTH
N
81°44'
41°30'
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15

PLATE A29

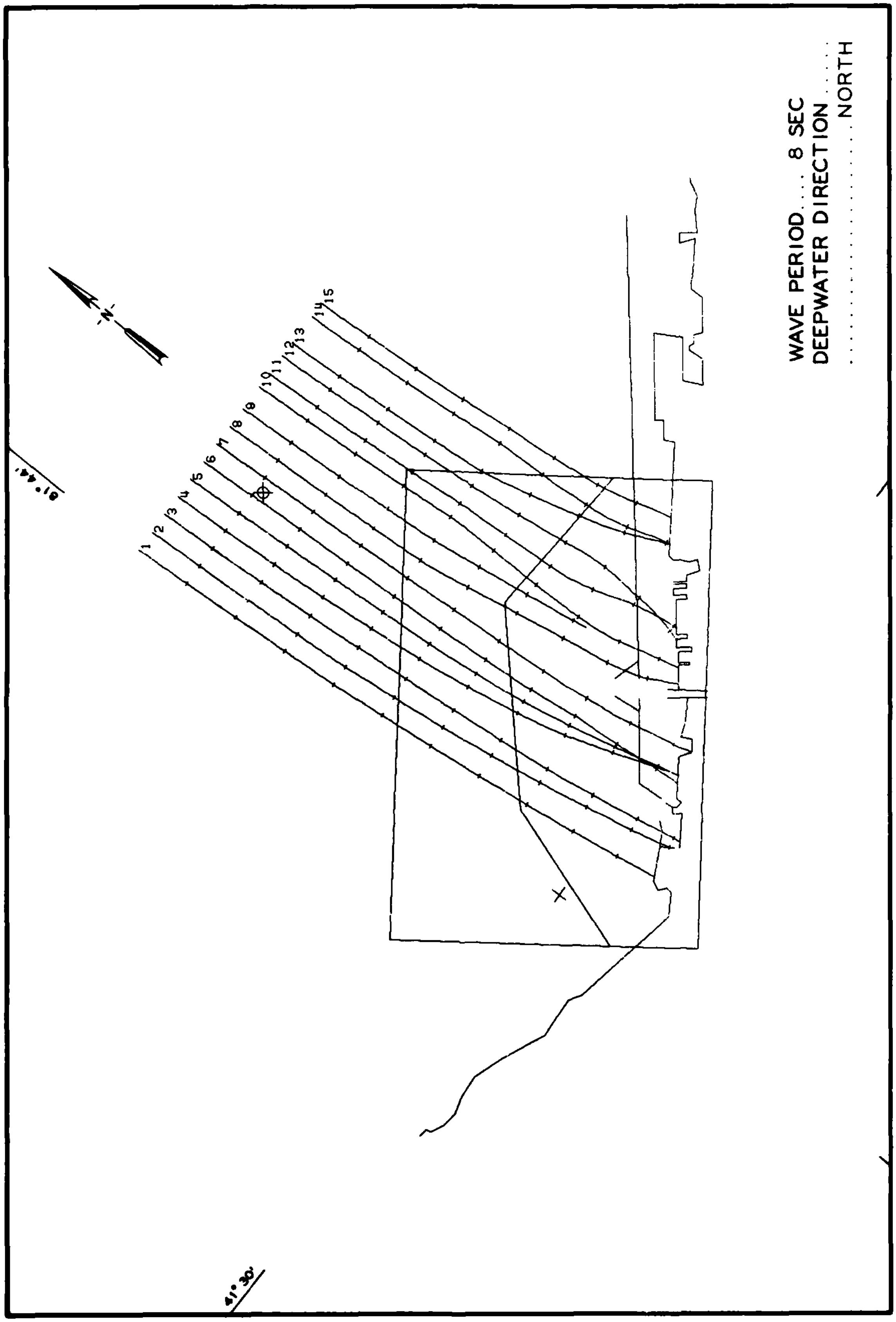

WAVE PERIOD.... 8 SEC
DEEPWATER DIRECTION ........ NORTH
N
81°44'
41°30'
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15

PLATE A30

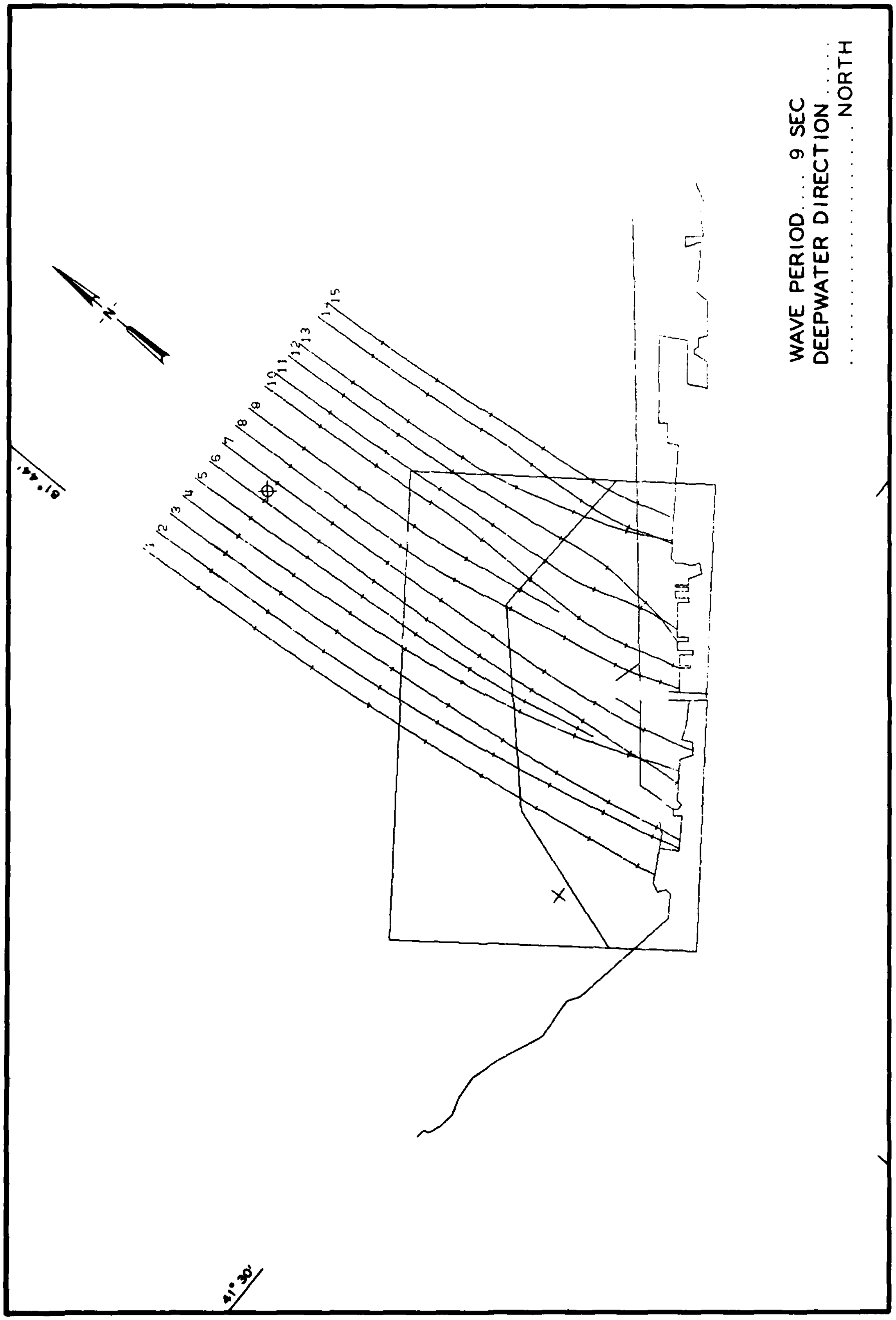



PLATE A31

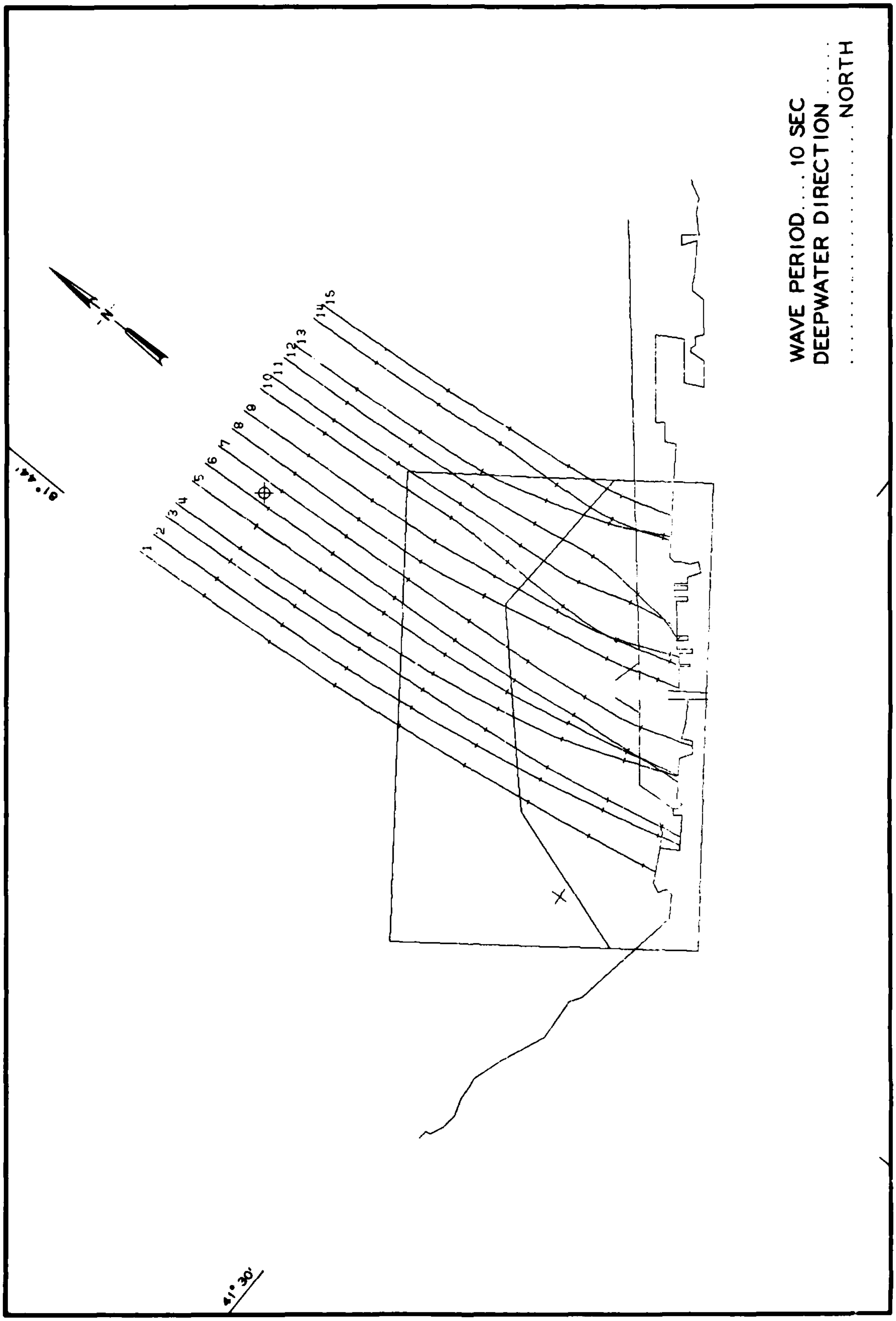

WAVE PERIOD . . . . 10 SEC
DEEPWATER DIRECTION . . . . . . . . . . NORTH
N
81°44'
41°30'
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15

PLATE A32

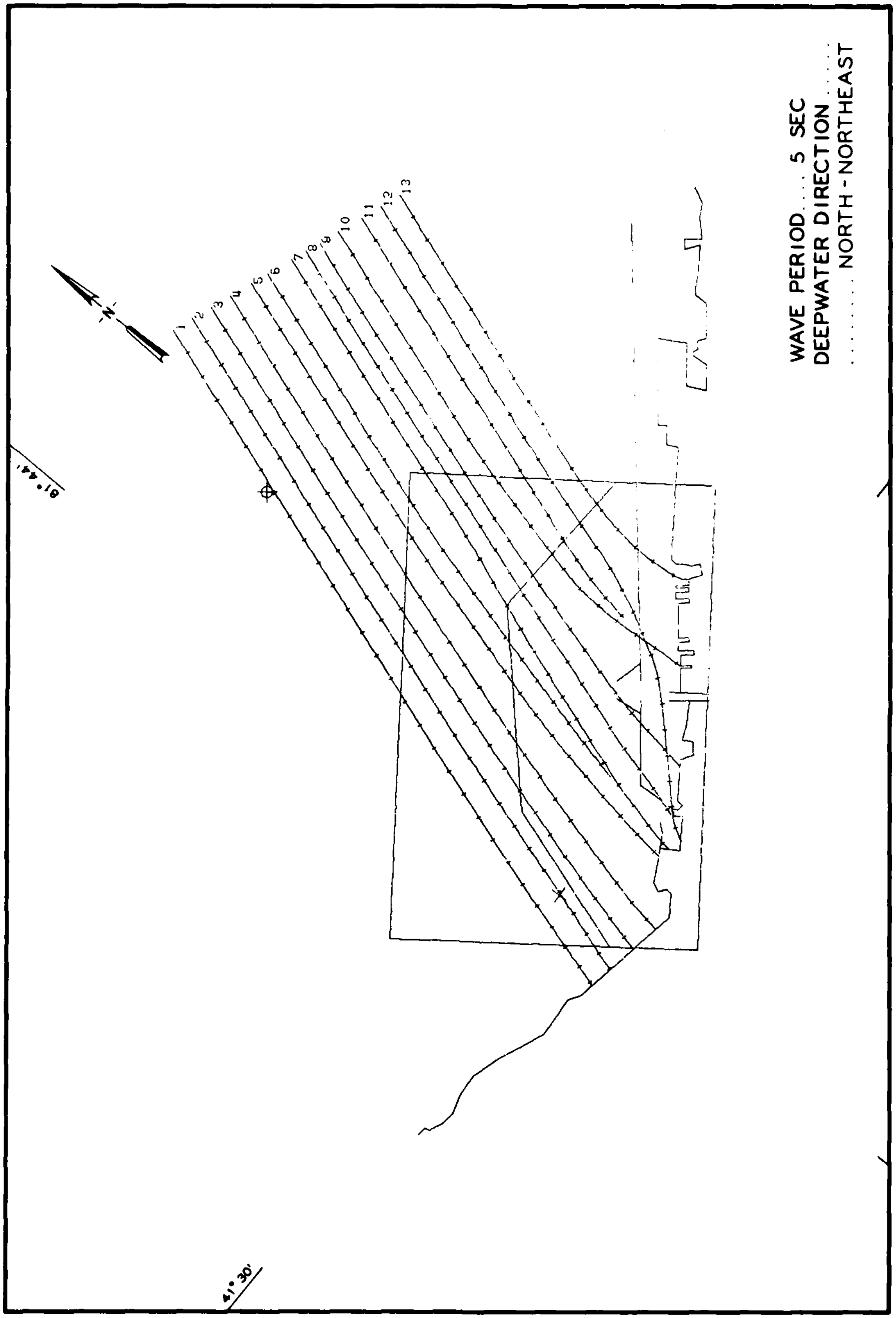

WAVE PERIOD .... 5 SEC
DEEPWATER DIRECTION .......
....... NORTH-NORTHEAST
N
81°44'
41°30'
1 2 3 4 5 6 7 8 9 10 11 12 13

PLATE A33

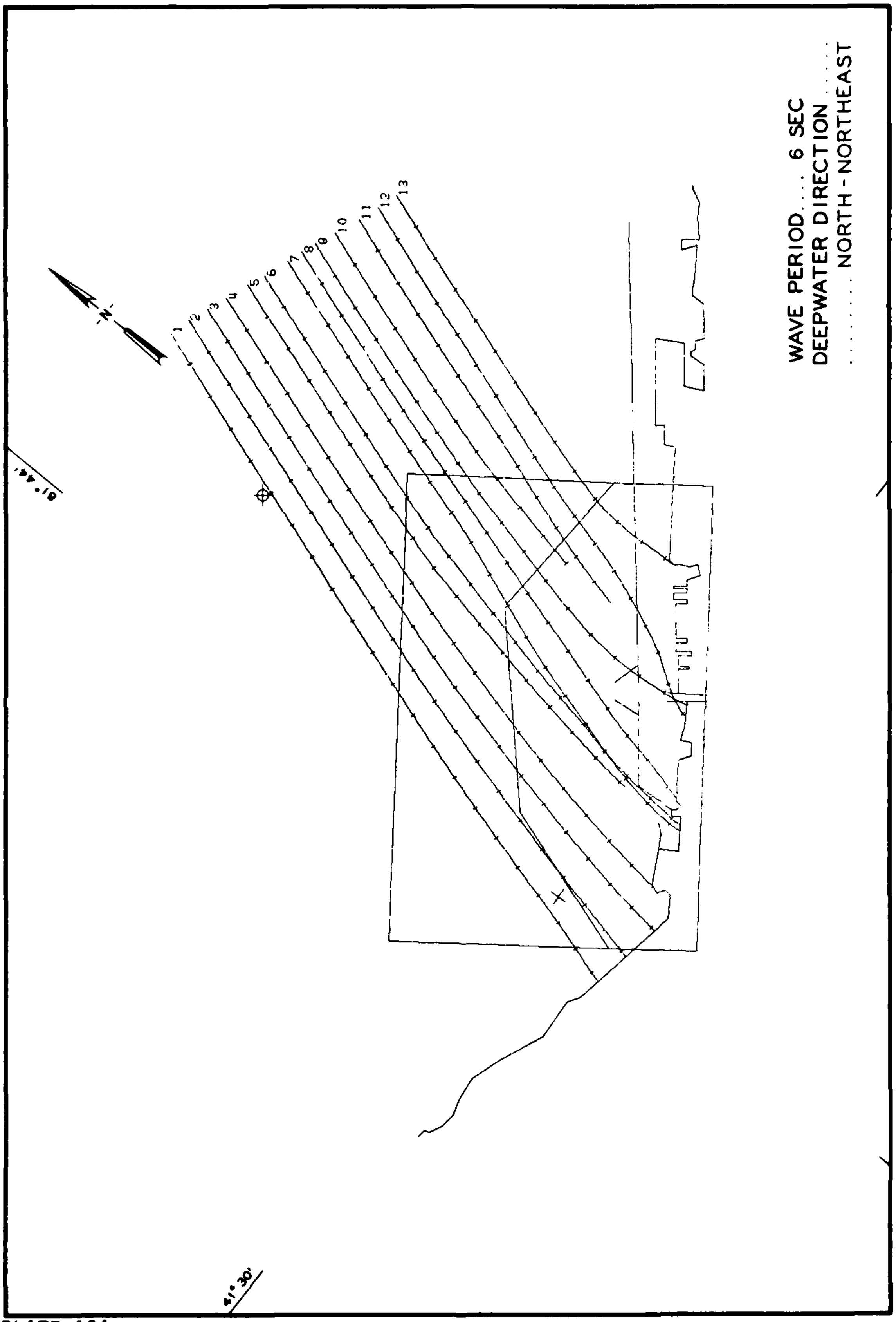
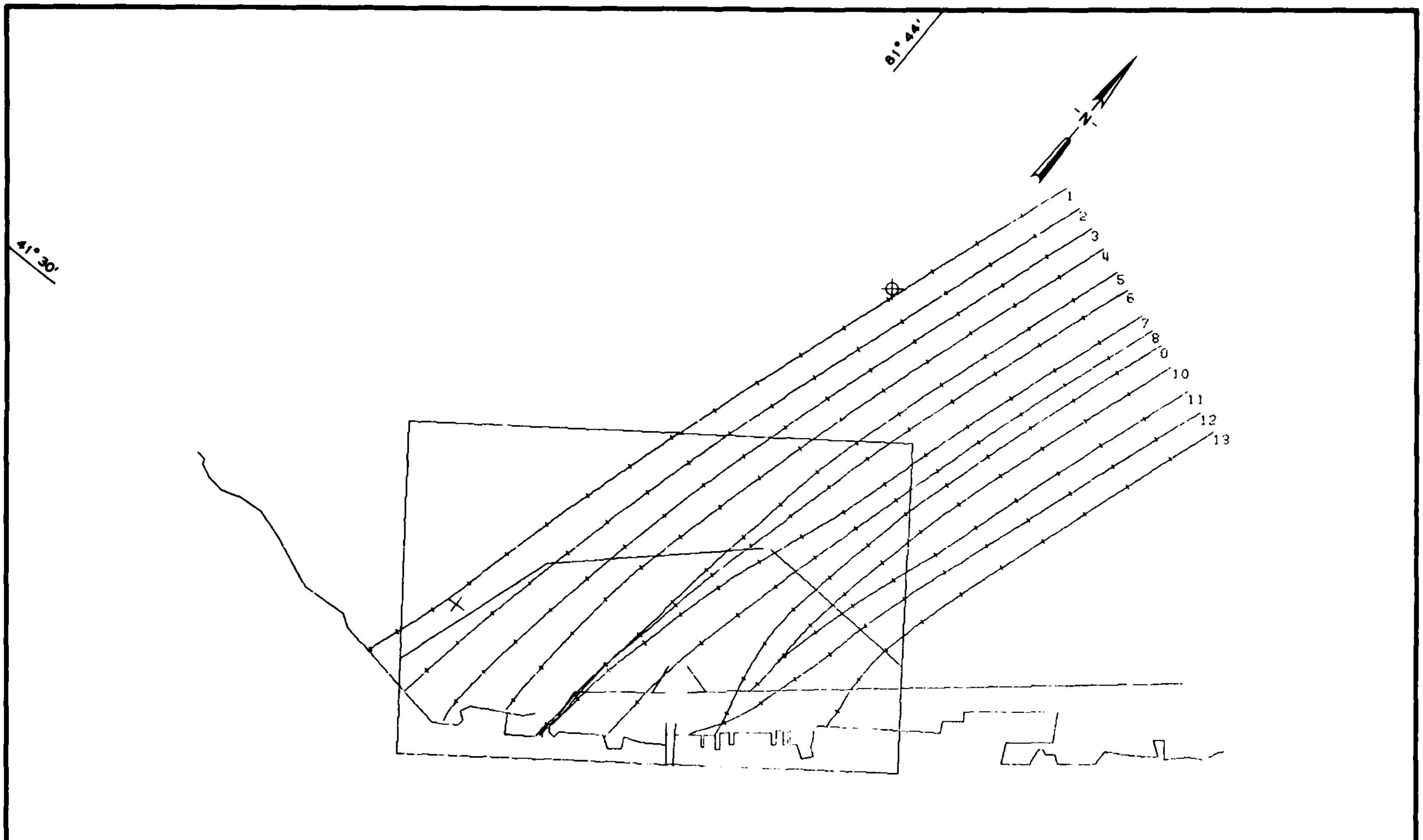

WAVE PERIOD ..... 6 SEC
DEEPWATER DIRECTION
......NORTH-NORTHEAST
1 2 3 4 5 6 7 8 9 10 11 12 13
N
81°44'
41°30'

PLATE A34




WAVE PERIOD.... 7 SEC
DEEPWATER DIRECTION.....
........ NORTH-NORTHEAST

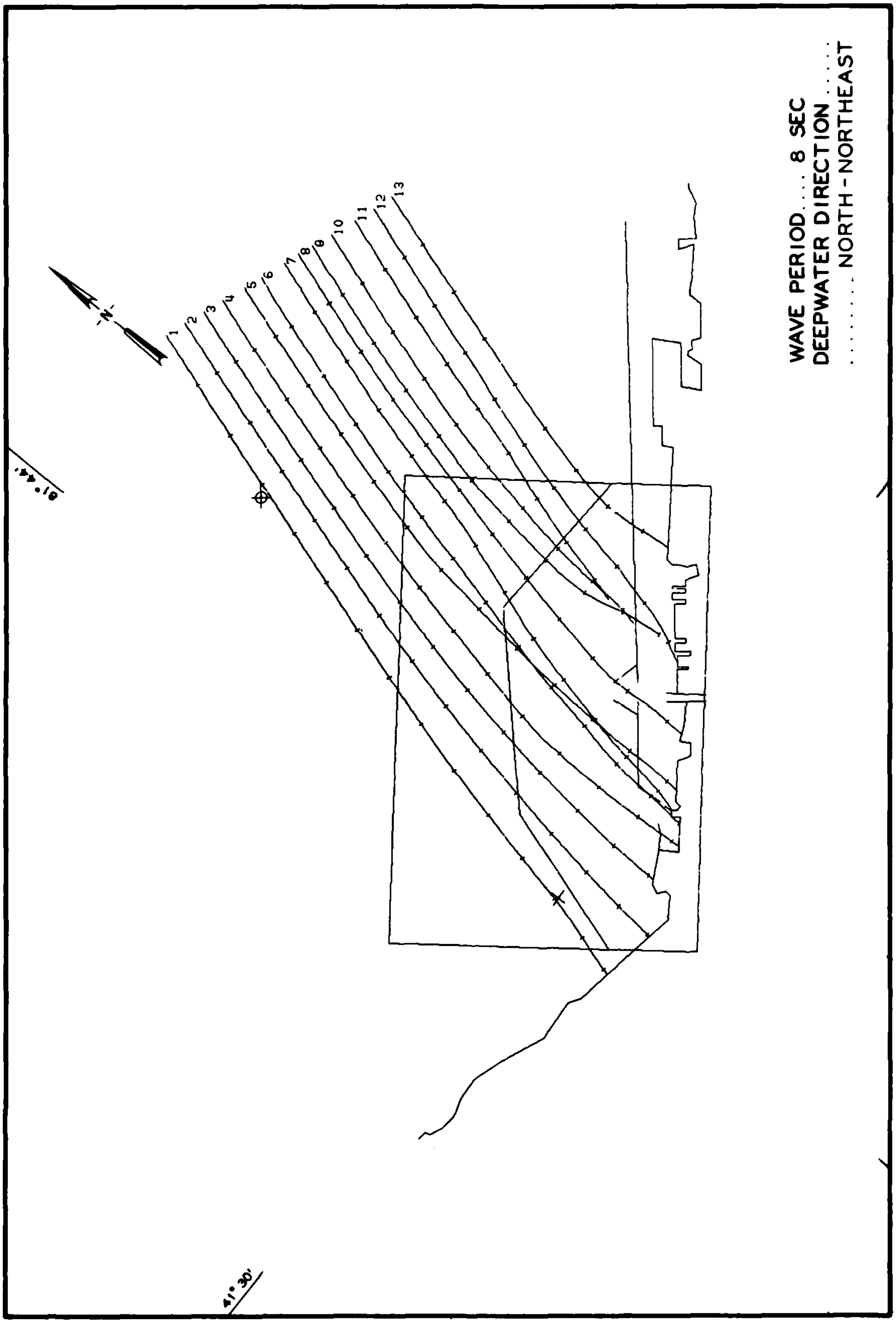

WAVE PERIOD .... 8 SEC
DEEPWATER DIRECTION ......
........ NORTH-NORTHEAST
N
1
2
3
4
5
6
7
8
9
10
11
12
13
41° 30'
81° 44'

PLATE A36

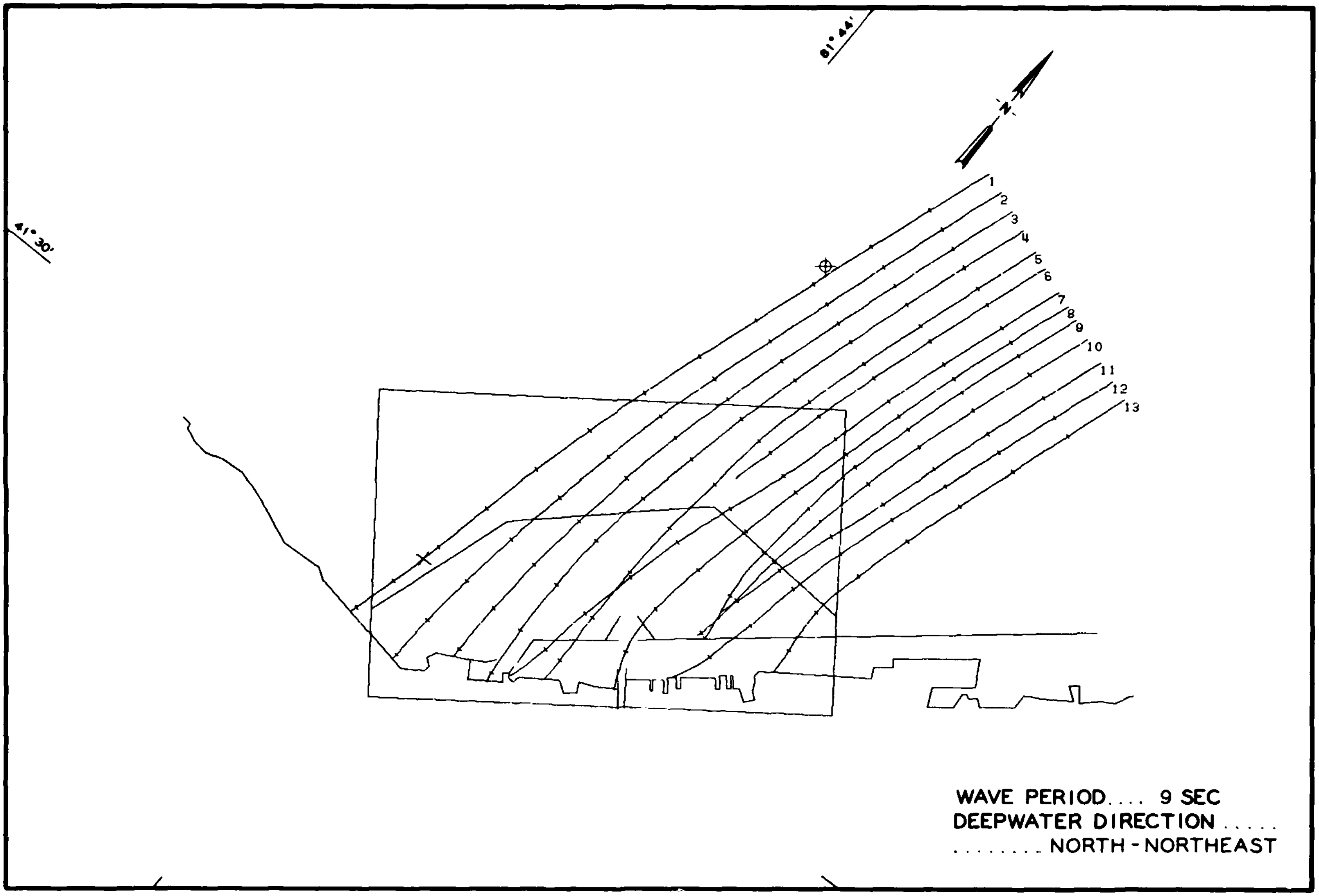

81° 44'
N
41° 30'
1
2
3
4
5
6
7
8
9
10
11
12
13
WAVE PERIOD.... 9 SEC
DEEPWATER DIRECTION.....
........NORTH-NORTHEAST

PLATE A37

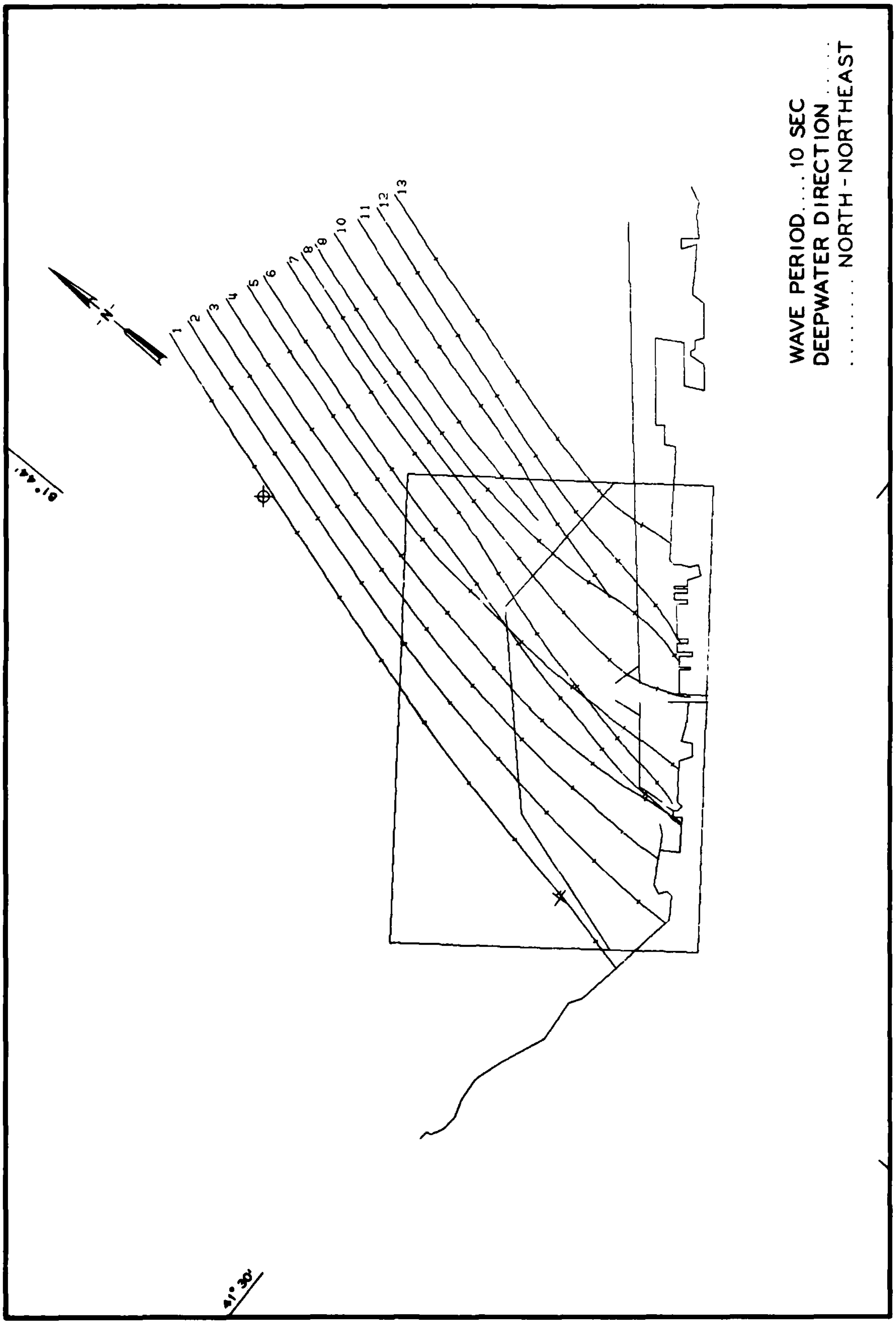

WAVE PERIOD....10 SEC
DEEPWATER DIRECTION
......NORTH-NORTHEAST
N
1
2
3
4
5
6
7
8
9
10
11
12
13
81° 44'
41° 30'

PLATE A38

## APPENDIX B: NOTATION

| | |
|---|---|
| $A$ | Area |
| $A_s$ | Lateral area of ship |
| $b$ | Shallow-water othogonal spacing |
| $b_o$ | Deepwater orthogonal spacing |
| $(b_o/b)^{1/2}$ | Refraction coefficient, $K_r$ |
| $C_y$ | Wind force coefficient factor |
| $F$ | Force |
| $F_w$ | Wind force |
| $H$ | Shallow-water wave height |
| $H_o$ | Deepwater wave height |
| $H_{1/3}$ | Significant wave height |
| $K_r$ | Refraction coefficient |
| $K_s$ | Shoaling coefficient |
| $L$ | Length |
| $Q$ | Discharge |
| $T$ | Time |
| $V$ | Velocity |
| $\forall$ | Volume |
| $V_s$ | Wind speed |
| $\rho$ | Density of air |
| $\gamma$ | Specific weight scale |

In accordance with letter from DAEN-RDC, DAEN-ASI dated 22 July 1977, Subject: Facsimile Catalog Cards for Laboratory Technical Publications, a facsimile catalog card in Library of Congress MARC format is reproduced below.

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